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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Eyes to See.

A number of British founders will shortly be crossing to France to participate in a business convention centred on foundry practice. There are to be three main features—technical sessions, an exhibition and works visits. Following precedent, the worst "order of batting" has been instituted. It would be best to review regional conditions by means of works visits, where certain operations are carried on with modern machinery or a definitely favourable result can be associated with a certain raw or intermediate material. Followed by a visit to a representative exhibition, further details of such machinery or material should be available, whilst at the technical session further enlightenment can be sought, especially at the informal luncheon table discussions. However, from an organisation point of view and from other aspects, too, the present system has much to commend it. A machine seen on a stand at an exhibition can later be seen operating under every-day works' conditions.

To obtain a maximum value from a conference of this character it is necessary that one should know intimately the conditions existing in one's own foundry. That is why it is best for the owner or director to be accompanied by the manager or foreman. The phases of foundry work to be taken into consideration before leaving the works are:—(1) Internal transport; (2) improved means of manufacture; (3) reduction of wasters; (4) improvement of product either in appearance or properties; and (5) new manufactures of a type suitable for existing or easily obtainable conditions. Immediately, the inspection of works changes from the admiration of the spectacular to an interesting study with definite objects in view. The study should commence with a survey of the elimination of handling movements with a mental approximation of the cost at which they are accomplished and obviously their applicability to domestic conditions. Any material advantage gained under heading No. (2) is rather a matter of luck, as it is unlikely that one encounters the manufacture of an article by a method which is not well known. For such articles as ingot moulds, chairs, cylinders of various types, axle boxes, and so on, though the practice may be entirely different from home conditions, still they are familiar to the progressive founder. It does happen occasionally that for less common types of castings a new method is exposed; and actually, in connection with the last Paris conference, a better method was disclosed which has been worth thousands of pounds to a North Midland firm of founders. Under the third consideration, we mean to indicate a special study rather than a general one. A firm may be experiencing defects of a specified character in certain of their castings, and every opportunity should be taken to ascertain its presence or absence, accompanied by explanation, in castings of a similar character.

The improvement of product in relation to appearance or properties demands close attention of the sand preparation, melting and moulding conditions associated closely with the system of control imposed. The importance of No. (5) is unquestionable. If machinery has been installed in a foundry and is at present unoccupied because of loss of orders for which it was installed—war material, for example—and one sees similar machines busy on, say, a domestic or agricultural casting, an endeavour should be made to attract that particular type of business.

In view of the above, the question is not one of whether one can afford to take part in a conference of this character, but whether one can afford to miss it.

Castings to Replace Forgings.

In recent years developments in engineering have made greater calls than ever on the steel foundries, to manufacture and supply, under increasingly rigid tests, products which previously were exclusively the work of the forger. The product, of which this article gives a short description, falls into this category with more compelling interest than many others. Chains in iron have been known practically since that material was first forged, and they have all, of course, been liable to the human element in the weld necessary in every link. The softness of the material to ensure that as perfect a weld as possible will be made, has to a certain extent, affected their useful life. Proposals have been made from time to time to manufacture these chains in cast steel.

Rigid Test Requirements.

These proposals interested the Admiralty, and various firms tackled the problem experimentally. Finally, Messrs. William Beardmore, of Glasgow, were successful in producing a finished cast steel chain which would pass the rigid test requirements laid down. The specification called for a 12½ fathom 3 in. cast steel stud link chain, with the necessary shackle. A testing length was to be selected by the inspector anywhere from the finished chain and subjected to the following tests:—

Shock Test.—Two single-links each to stand 15 blows with a 1 ton tup without sign of fracture as follows:—Two blows at 10 ft.: two blows at 15 ft.; and 11 blows at 20 ft.

A three-link sample from test length was to stand without sign of fracture a proof load of 204 tons, the overall elongation not to exceed 1 in. at this load. The sample was then to be loaded till fracture occurred, and to give a breaking load not less than 306 tons. The whole chain was then to stand a proof load of 204 tons. The high standard required can be understood by considering beside these figures the corresponding tests required on a standard 3 in. wrought-iron cable chain. These are: Tup test, nil; proof load, 145.8 tons; breaking load, 218.7 tons. It will be noticed that the proof load stipulated for the cast steel chain is the breaking load accepted for the wrought-iron chain.

After the various manufacturing difficulties inherent to a proposition of this nature were overcome, a complete chain was manufactured for the Admiralty which fulfilled all their test requirements. This chain is at present in service, and the result of its performance is awaited with confidence.

Completed Chain.

The Admiralty proof load of 204 tons was applied without fracture. Total extension of chain at this load was 15½ in. measured on a length of 73 ft. The successful production of this chain in cast steel is typical of the high standard of workmanship and material, and is an indication of the difficult class of work which can be undertaken at Parkhead Works. The method adopted in casting has ensured perfect solidarity in the links. A number of these have been sawn up across all sections, and have been found free from defects.

Cash Rebates on Steel Purchases.

It is reported from Middlesburgh that a system of cash rebates for customers who agree to purchase exclusively British steel over a definite period is shortly to be introduced by British steelmakers. The scheme has been completed, but has not yet been made public, as all steelmakers have not yet given their assent.

The introduction of cash rebates should do much to retain an increased volume of business for British manufacturers and to restrict to some extent the continued importation of cheap Continental material.

Master Cutler Elected.

Last Tuesday Mr. Percy Lee, managing director of Messrs. Arthur Lee & Sons, Limited, Crown Steel and Wire Mills, Sheffield, was elected Master Cutler of Sheffield for the ensuing year. The installation is to take place on October 4.

Iron and Steel Institute.

Papers for the Glasgow Meeting.

In accordance with previous announcements, the Autumn Meeting of the Iron and Steel Institute will be held, by kind invitation of the President (Mr. John Craig, C.B.E.), and Council of the West of Scotland Iron and Steel Institute, at Glasgow. The sessions will take place at the Royal Technical College, Glasgow, on Tuesday, Wednesday and Thursday, September 20, 21 and 22, commencing at 10 a.m. each day.

The following Papers are expected to be submitted to the meeting:—

1. "High-Frequency Induction Melting," by D. F. Campbell.
2. "Magnetic and other Changes concerned in the Temper-Brittleness of Nickel-Chromium Steels," by H. A. Dickie.
3. "The Influence of Cold-Rolling and Subsequent Annealing on the Hardness of Mild Steel," by C. A. Edwards and K. Kuwada.
4. "The Influence of Nickel and Silicon on an Iron-Carbon Alloy," by A. B. Everest, T. H. Turner and D. Hanson.
5. "The Effect of Varying Ash in the Coke on Blast-Furnace Working," by C. S. Gill.
6. "The Constitution of Silicon-Carbon-Iron Alloys, and a New Theory of the Cast Irons," by D. Hanson.
7. "The Work-Hardening of Steel by Abrasion," by E. G. Herbert.
8. "On the Quantitative Measurement of the Cutting Power of Cutlery," by K. Honda and K. Takahasi.
9. "The Use of Silica Gel as a Medium for Drying Blast," by E. H. Lewis.
10. "The Mechanism of Tempering of Steels," by T. Matsushita and K. Nagasawa.
11. "The Economic and Social Development of the American Iron and Steel Industry," by T. W. Robinson.
12. "The Behaviour of Mild Steel under Prolonged Stress at 300 deg. C., by W. Rosenhain and D. Hanson.
13. "A Testing Machine for Repeated Impact, and a Preliminary Investigation on the Effects of Repeated Impact on Lowmoor Iron," by J. H. Smith and F. V. Warnock.
14. "The Solution of Carbon in α-Iron and its Precipitation," by J. H. Whiteley.
15. "A Contribution to the Theory of the Blast-Furnace Process," by F. Wüst.

Core Baking by Electricity.

Electrically-heated core ovens are being made by the Edison Electric Illuminating Company, Boston, U.S.A. These ovens are used for cores varying from less than an ounce to as much as 400 lbs. each, required in making intricate castings used in the manufacture of laundry machinery.

Two large ovens are of the car type, with capacity for a charge of about 24,000 lbs., including weight of car. With this charge, each kw.-hr. bakes about 15 lbs. of cores. Six ovens somewhat smaller are of the truck type, handling many of the larger cores, the trucks being charged into the oven by an electric tractor. Two smaller ovens are of the rack type, the cores being placed on individual racks, which then are placed in the oven and take the form of shelves along the walls.

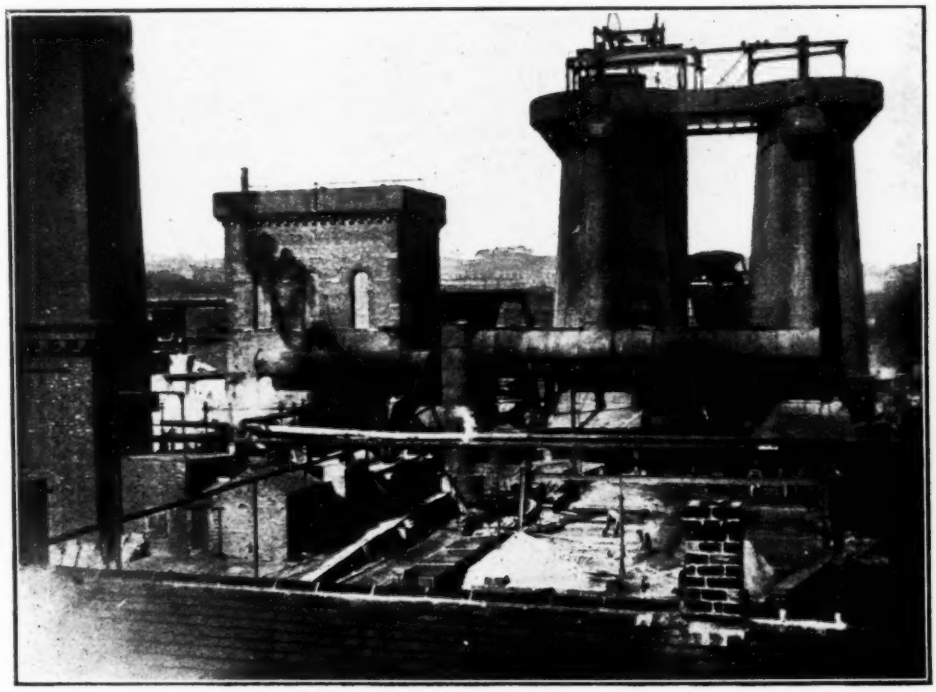
Each oven is heated by several banks of ribbon resistor units mounted on the side walls and in a pit beneath. Each side wall and the pit supply about one-third the heat. Each unit is rated at 3.8 kw. on 110 volts. The necessary heating capacity of each oven is obtained by installing the required number of units.

Temperature controls and electric contact regulators are used during the process. The control is said to be within 3 deg. C., current being turned on or off according as the temperature drops below or goes above the set point. The time regulator can be set for any desired length of baking period. The heat may be turned on at any designated time in the future, the operation being entirely automatic, both as to turning on and turning off.

The Value of Cold-Blast Pig-Iron.

It has long been known, certainly for more than three-quarters of a century past, that genuine cold-blast pig-iron is a much superior product to the ordinary hot-blast iron, particularly for foundries, two of the most important fields, for example, being for heavy work where great strength is required, and for light, hollow castings that have to be extremely tough. Also another field is the application to the manufacture of chilled rolls and the best class of engine cylinders, giving a metal of great strength and extreme closeness of grain.

There is no question, however, that to-day many foundrymen, and engineers in general, do not quite understand the circumstances, especially because of the complications due to various cheap and low-grade substitutes that have been placed on the market in competition with genuine cold-blast iron under the name of "cold-blast refined iron," which in many cases is merely an inferior mixture of scrap steel and hot-blast iron.



The Blast Furnaces at Low Moor Ironworks.

It will be remembered, of course, that for many years past the standard blast-furnace practice has been to use a regenerator to increase the thermal efficiency, that is the "Cowper" stove, which followed upon the earlier designs based on the recuperative principle, such as the "pipe" stove. One has to admit, however, that the use of a hot blast in this way, although reducing the cost of the process, gives an inferior product, and in these days of speeding up and increased stresses and strains it is often a paying proposition to use genuine cold-blast iron in spite of its higher price.

Very interesting in this connection is that Messrs. Robert Heath and Low Moor, Limited, have specialised in the production of this cold-blast pig-iron ever since the Low Moor Works started in 1791, and, in fact, their blast-furnace plant—which to-day has a throughput of approximately 250 tons of iron per week on normal working—has never been fitted with any "Cowper" stove or other regenerative or recuperative design to increase the temperature of the air, which is supplied direct to the furnace in the cold condition at varying pressures up to 3½ lbs. per sq. in.

The reason why cold-blast iron possesses such superior properties still remains a mystery, in spite of all the different theories that have been adduced, and it is well known, of course, that many other matters in connection with blast-furnace operation are just as obscure, since the chemical reactions taking place under such conditions of a huge solid mass at a very high temperature are almost bewildering in complexity. The mere chemical analysis of pig-iron is, of course, only a partial guide of its real qualities from the practical point of view. Thus, for example, a typical "Low Moor" cold-blast pig-iron suitable for chilled castings has an analysis of 0.70-1.10 silicon, 0.08-0.14 sulphur, 0.40-0.50 phosphorus, and 0.60-1.25 per cent. manganese, this being a high-grade product extremely low in phosphorus, and it may be stated also that in the manufacture of this iron there is used only the "Better Bed" coal for the coking ovens on the Low Moor estate, which gives a metallurgical coke of only 0.45 per cent. sulphur, while further, the local ironstones are used, known as the "Black Bed," the close proximity of these two products of unusually good quality having, of course, been the reason why the works started on the site 136 years ago.

But these analytical figures by themselves do not tell the whole story, and the real explanation remains to be found. Incidentally it may be mentioned that some time ago there was put forward by Johnson the theory that a small quantity of ferrous oxide present in pig-iron improves the quality, and that this is probably the reason for the superiority of cold-blast iron. However, this theory is no longer regarded as tenable, and there is no real reason for believing that ferrous oxide can exist in pig-iron containing silicon even at the low figure of 0.50-1.0 per cent., such as in "Low Moor" cold-blast iron.

Finally, it will be interesting to recollect the remarks made by Dr. Richard Moldenke at the recent annual meeting (1927) of the American Institute of Mining and Metallurgical Engineers. He stated, which is, of course, very true, that most foundrymen know to-day that they are getting poorer castings with the pig-iron supplied than they did a number of years ago, in spite of the growing uniformity of the metal, because of the greater tonnage of production and the increase in scientific methods so far as analysis of the iron and control of the blast furnace is concerned. He points out that in one way the history of the production of pig-iron for foundry work is lamentable in that it shows a gradual lowering of quality, beginning with genuine cold-blast pig-iron and descending through anthracite iron and coke iron to the latest modern hot-blast pig-iron with an enormous throughput, to say nothing of the principle of mixing in scrap steel.

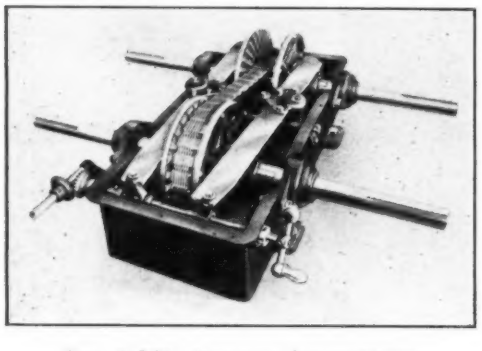
XUM

Positive Drive Infinitely Variable Gear.

Undoubtedly one of the most important inventions of recent times in the world of power transmission is the "P.I.V." (Positive Infinitely Variable) Gear, which, it will be remembered, allows, for the first time, with truly positive (non-slipping) transmission, of an infinite number of speed variations being given—at any centre distances—to a driven shaft from a constant speed driving shaft. This is of considerable interest in connection with modern foundry machinery, including centrifugal casting, for example, and general electric driving, giving an accuracy of speed control in a manner hitherto considered impossible.

There are three standard types, totally-enclosed short-centre "P.I.V." gear boxes, running in oil, of 10, 5, and 3 h.p. respectively, allowing a speed variation in each case within a ratio of 4:1. That is to say, with regard to the constant speed driving shaft, which may be at any desired figure, for example, 750 r.p.m., the driven shaft can be varied infinitely merely by the control of a single handle between the speeds of, say, 350-1,400 r.p.m. (4:1) or any similar range.

Another model consists of a totally enclosed "P.I.V." gear box in which a continuously varying speed can be given to the driven shaft within any desired range in relation to the driving shaft. The latter, in this case, runs at 300 r.p.m., and the driven shaft starts at 330 revolutions and



The P.I.V. Gearing Arrangement.

falls continuously and infinitely to 270 revolutions in 50 minutes, at the expiration of which period it automatically returns within 4 seconds, by means of a spring device, to 330 r.p.m., being a new principle in power transmission.

A typical example of an application of this character universally applicable to the electric driving of industrial establishments is a motor running at a constant speed of 1,000 r.p.m., and allowing an infinite variation in speed of the driven shaft, at any centre distance, of between, say, 250-500 r.p.m., merely by operating a wheel valve control on the motor shaft.

Very many important modifications of the "P.I.V." gear are also now available, and a large number of gears are in commercial operation, a few examples being bakers' continuous ovens, biscuit machinery, electric cable manufacture, paper-making, printing, pumping, condensed milk machinery, bleaching, silk spinning, and the manufacture of matches, cement, and glass bottles, while the efficiency of the results obtained is of course obvious, as shown by the recent National Physical Laboratory Report. Finally, as one example, characteristic of the above applications, is a "P.I.V." gear box used in the manufacture of electric cables, in which the driving and driven shafts extend on each side of the box, the distance between their centres being arranged according to the requirements of the machine, for which two gears are required. Remote control of the speed variation is also obtained by means of an ordinary chain and sprocket wheel operating through a small pair of bevel wheels, while one of the latest modifications has a vertical driven shaft with infinite speed variation as compared with a constant speed horizontal driving shaft.

Swedish Import Duties on Iron and Steel.

The Swedish Ironmasters' Association (Jernkontor) has again approached the Government with a view to securing a greater measure of protection for the home industry to meet the growing foreign competition.

It is pointed out that the Swedish consumption of merchant steel, bars, wire, plates, etc., as far back as 1913, amounted to 444,579 tons, of which 149,541 tons were imported, and about 295,000 tons were produced in the country itself. In 1926, however, the imports reached 220,423 tons, or an increase of nearly 50 per cent. over those in 1913. On the other hand, the total production of wrought iron and steel in Sweden in 1913 was 749,400 tons, but in 1926 it was only 519,300 tons, or a decline of about 45 per cent. During the first quarter of 1927 the imports further advanced by 27,222 tons over the corresponding quarter of last year. Thus it will be seen that foreign iron and steel makers are making increasing inroads into the Swedish market for merchant iron and steel. The chief reason seems to be over-production in Germany, France and Belgium, necessitating the practice of dumping on the Swedish market. The prices charged by France and Belgium are lower than those of the Germans, which is due not only to the depreciated currencies of these two countries, but also to the circumstance that as a consequence of the expansion in their iron and steel industries since the war they are compelled to seek fresh markets.

As far back as 1924 the German works quoted export prices, which were 10 per cent. below their inland prices. The difference slowly increased and amounted to about 37 per cent. in July, 1926, but declined to about 17.5 per cent. after the formation of the Continental Steel Trust. The actual (as contrasted with the official prices), however, are considerably lower, so that the real difference is about 32 per cent., if not higher.

As the Continental Steel Trust is only controlling the production of its members, but exercises no influence on sale prices, the Swedes consider that a continuation of the dumping policy will have to be reckoned with. Moreover, as the purchasing power of money has diminished by about 70 per cent. since 1913, the Swedish Jernkontor is of opinion that it will be necessary, without delay, to introduce an increase of 60 to 70 per cent. in the import duties. The Kontor has therefore suggested to the Swedish Government that the duty on pig-iron, castings, etc., should be increased from present 20 to 35 kr. per metric ton on shapes, angles and other hot-rolled iron and steel weighing from present 60 to 20 kg. per metre run, from 15 to 35 kr.: and on all such material of less weight per metre from 25 to 45 kr.; sheets of 3 mm. or over from 30 to 50 kr.; sheets of less than 3 mm. down to 0.6 mm. from 45 to 75 kr., sheets of 0.6 mm. to 0.3 mm. from 50 to 90 kr.; rolled or hot-drawn tubes, rough, from 40 to 65 kr., and tubes, finished, from 50 to 80 kr.; and structural iron and steel from 45 to 65 kr. the metric ton. (The current rate of the krone is 18.11 to 18.12 kr. to the £.) It is further noted that considerably lower prices are quoted by foreign works for cold-drawn tubes, malleable castings, and other goods of wrought-iron.

Gazette.

At the first meeting of creditors held recently at the Bankruptcy Court before Mr. E. Parke, Official Receiver, under the failure of Mr. Fred Gardiner Martin, trading as Stedman Crowther & Company, metal merchants and agents, 148½, Fenchurch Street, E.C., the debtor, who filed his petition on July 26, stated that he was admitted a partner in the firm in 1912, the business being conducted in London, Manchester and Liverpool. Just after the war his partner, Mr. J. C. Crowther, retired in consequence of ill-health, and the debtor agreed to repay that gentleman's capital of £41,000 by instalments with 5 per cent. interest. In addition, the debtor agreed to pay his late partner £1.000 per annum for life. He made the payments regularly until July, 1926, but a client owing between £26,000 and £30,000 then defaulted, and as he was unable to pay the instalment then due, Mr. Crowther issued a writ claiming about £30,000, obtained judgment in respect of his claim, and the garnisheeing of the debtor's private and business banking accounts followed. Owing to that action and the stoppage of his credit the debtor was advised to file his petition. No accounts had been lodged, but the debtor roughly estimates his liabilities at £60,000, and values his assets at £2,000, apart from book debts and shares of doubtful realisable value. In the absence of any proposal Mr. V. S. Wright, I.A., was elected as trustee to administer the estate in bankruptcy.

The Influence of Aluminium on an Iron-Carbon Alloy.

By Arthur B. Everest, Ph.D.

Introduction.

Within recent years aluminium has been commonly used as a deoxidiser for iron and steel, but in the foundry it has been generally believed that aluminium added in more than the small quantities necessary for this purpose renders the metal sluggish in pouring, and hard, brittle, and unsound when cold. In brief, it has been held that aluminium has a deleterious effect on the metal, and this idea, taken in conjunction with the somewhat unsatisfactory results of early researches on the influence of aluminium on cast iron, has caused further investigation in this subject to be neglected. Reference to the bibliography given below reveals the fact that there has been little fundamental research in this field published since the year 1900.

The analogy existing in chemistry between aluminium and silicon is borne out in the early metallurgical researches reported, there being distinct evidence that aluminium acts on cast iron in a manner similar to that in which silicon acts, it appeared accordingly that the investigation of the influence of aluminium on cast iron might lead to results useful to industry as a whole, and yield information which would settle once for all the question as to whether aluminium could be usefully added to cast iron or not.

After the development of suitable methods of introducing the aluminium into the cast iron, a preliminary qualitative investigation of the series formed by adding from 0-30 per cent. of aluminium to a pure cast-iron base (American washed iron) has been carried out.

The tests throughout this series have been of a general qualitative nature, and were intended as a preliminary survey, and to indicate those ranges of alloys which might with profit be investigated in further detail with a view to their commercial application.

Bibliography.

Two Papers were published by W. J. Keep (1 and 2) in 1888 and 1889 dealing with the influence of aluminium on white and grey cast irons. His results are somewhat qualitative, and are vitiated by the presence of silicon and other impurities in the iron. Ferro-aluminium containing 11 per cent. Al and 3.86 per cent. Si was used for making additions, and consequently it is somewhat doubtful how far the effects produced are due to aluminium and how far to the combined action of aluminium and silicon.

Keep showed that 0.1 per cent. Al rendered cast-iron and steel mixtures, and cast steel itself, sound, but this is probably due solely to its action as a deoxidiser. Strength, consequently, increased with the soundness of the casting. He noted that in each case 1 per cent. Al caused a precipitation of graphite in the iron, with consequent lessening of shrinkage and chill.

In his second Paper Keep (2) showed that aluminium itself in the absence of silicon acts as a precipitant of graphite more powerfully than does silicon. He attributes the lowering of total carbon in the metal to loss of graphite as kish from the molten metal.

In 1893 T. W. Hogg (3) began investigations on the influence of aluminium on the carbon in ferro-carbon alloys, and investigated the solubility of carbon in ferro-aluminium containing 10 to 20 per cent. Al.

In 1894 Hogg (4), in the publication of further work, stated that 1 per cent. Al when added to white iron causes the precipitation of nearly all the carbon as graphite, while at 12 per cent. Al the carbon is again all combined. He found that the metal contained slag and the test pieces were porous; also, that there was large gas evolution on pouring the metal.

In the same year K. Styffe (5) advocated the addition of 0.25 per cent. Al to white iron and high-carbon steel to convert a portion of the combined carbon to graphite, giving denser, more uniform, and more machineable castings. He also stated that malleable iron and steel were hardened and made stronger by the addition of up to 0.75 per cent. Al. Above 5 per cent. Al he found the alloys more or less brittle.

In 1900 Melland and Waldron (6) published a joint Paper on the influence of aluminium on the carbon in cast iron. Alloys were made up by pouring iron into molten aluminium; test pieces were then cast (a) in chill moulds, and (b) in red-hot carbon moulds. A lowering of total carbon much less than that obtained in the present research is recorded, *e.g.*, 0.439 per cent. on 3.51 per cent. at 11.8 per cent. Al. Maximum precipitation of graphite (T.C., 3.9 per cent.: Gr.C. 3.0 per cent.) was obtained between 0.23 and 1.78 per cent. Al. Above 1.78 per cent. Al, graphite diminished, until at 11.8 per cent. the graphitic carbon is 0.2 per cent. Aluminium has a less powerful influence than silicon, in that 0.9 per cent. C.C. is always retained, but acts more powerfully at low percentages, *e.g.*, at 0.5 per cent. Al; slow cooling, obtained by casting into red-hot moulds, would account for the large precipitation of graphite recorded between 0.23 and 1.78 per cent. Al.

Adamson (7) in 1906 noted that aluminium in small quantities in cast iron reduces the depth of chill.

In his work on the influence of elements on graphite in cast iron, Hamasumi (8) noted that small additions of aluminium gave him thick melts and that he could not obtain sound test pieces.

Some work has been performed on aluminium steels. In 1890 R. A. Hadfield (9) published a Paper on this subject, but found that above 5 per cent. Al the metal became creamy, possibly due to slag entrapped in the metal, and set quickly. He found the aluminium steels were forgeable with aluminium up to 5.6 per cent., and the alloys machineable up to 7 or 8 per cent. The aluminium dissolved in the steel with recalescence, and Hadfield attributed this to the heat of formation of compounds. This view was confirmed by the results of some experiments by Stead, quoted in the discussion of the above Paper.

Methods of Making up Alloys.

It was originally intended to make up the alloys of aluminium and cast iron by adding a suitable temper alloy in powdered form to the molten iron. (This was to prevent undue loss of aluminium by oxidation on making the addition.) Efforts to make up an alloy of anything approximating a composition of 50 per cent. of aluminium in wrought iron, steel or cast iron were unsuccessful, for these alloys have very high melting points, and even when made, are very unstable, and decompose and disintegrate in the atmosphere, due to oxidation and the action of moisture.

In further experiments, in which aluminium was added gradually to molten iron in order to make up temper alloys carrying a smaller amount of aluminium, it was realised that there was no difficulty in adding aluminium itself direct to the metal, and consequently this procedure has been adopted throughout the course of the present work.

In making up the alloys reported in the preliminary tests below, the iron was melted in a clay crucible in a wind furnace, and the aluminium was added cold in small pieces, these being thrown into the iron and stirred in with an iron rod. Initially a flux of borax or cryolite was used on top of the melt, but as no advantage was apparent in this, its use was discontinued. By this method the loss of aluminium was in general about 5 per cent. of that added.

In the latter part of this work, when larger melts of aluminium cast iron were made, it was found advantageous to add aluminium in a molten form to the iron. Provided the iron is

in the first place well melted and fluid, the aluminium mixes with it quietly and no signs of boiling up or spitting of the metal are observed. In all cases carbon is ejected from the iron and floats as kish on its surface; this is particularly marked with the alloys containing the higher percentages of aluminium.

It has been observed that on throwing or pouring the aluminium into the iron a pasty mass is first formed, and this subsequently dissolves in the remainder of the iron with intense recalescence. This has been attributed to a thermit reaction involving the deoxidation of the iron by the aluminium but in the opinion of the author it is more likely due to the heat of formation and subsequent solution of the compound Al_2Fe_2 of (9). For the intensity of the recalescence is proportional to the amount of aluminium added and is very marked in cases where subsequently no loss of aluminium in making up the alloy, is recorded. Local surface temperatures as high as 1,680 deg. C. have been measured with the Cambridge optical pyrometer on adding 20 per cent. of cold aluminium to iron initially at about 1,300 deg. C.

It has been found essential to work with the iron base heated well above its melting point; if the iron is too cool the aluminium tends to yield a sluggish melt, and any aluminium oxide formed in the body of the metal is trapped. In general the aluminium has been added to the iron when the latter is at about 1,280 to 1,320 deg. C.

Preliminary Investigation of the Influence of Aluminium on Cast Iron.

In order to determine the fundamental influence of aluminium on cast iron, a series of alloys has been investigated, made up with from 0 per cent. to 30 per cent. of aluminium added to American washed iron. The analysis of this iron is: T.C., 3.5; Gr, trace; Si, 0.029; S, 0.028; P, 0.016 per cent.; and Mn, nil, giving 0.073 per cent. total impurities apart from carbon.

The micro structure of this iron in the pig form shows pearlite areas in a matrix of austenite-cementite eutectic. There was no sign of free carbon.

Form of Test.

Throughout this series it was decided to use Keep's shrinkage test, since this test not only provides valuable information as to shrinkage, depth of chill, etc., but also furnishes a casting of convenient form for testing for general properties, hardness, specific gravity, etc.

It was found, however, that owing to the somewhat sluggish nature of some of the melts, the arrangement of runners and risers had to be modified. In this test two bars each 12 in. × ½ in. × ½ in. were cast.

The castings were in general left in the mould from 5 to 10 mins., and were then knocked out. When cold the test bars were broken from the runners and cleaned, and the shrinkage measured in the usual manner.

The appearance of the test bar and of its fracture were noted. The end of one bar was carefully broken to note the depth of chill. Samples, where machineable, were drilled for analysis; otherwise they were crushed in a mortar. Specimens for micro examination, specific gravity, etc., were cut or broken off. About 6 lbs. of cast iron were required for each test.

Pouring.

When the metal had been skimmed it was poured as quickly as possible. A skin was always found on the molten metal, and pouring had to be steady and uninterrupted to prevent this skin being carried into the body of the casting, where it would be found ultimately as an inclusion of oxides of aluminium and iron.

Appearance and Nature of Castings.

Test No. 1 of the orginal iron was very unsound and porous; however, in all cases on the addition of aluminium sound castings were obtained. Actually 0.25 per cent. of aluminium gave a sound casting, but the fracture was white and the metal very hard; the skin of the casting was grey, with adherent sand. These were the general characteristics of all the castings up to 1 per cent. Al. Above 1 per cent. Al the skin of the casting became grey and clean, while the fracture was grey and the castings were very tough. Above 8 per cent. Al the castings became very hard and brittle, and the skin and fracture were silvery white. At 18 per cent. Al another change was noticed, and the castings became grey again in fracture, and in the colour of their skin, while they were less brittle and softer. This state persisted in a decreasing degree up to 30 per cent. Al. These changes are expressed quantitatively in the curves given for hardness, etc., which follow. All curves are drawn as properties plotted against the amount of aluminium found by analysis in the metal.

TEST RESULTS.

Total Carbon.

Fig. 1 shows the curve connecting the amount of total carbon in the alloys with the aluminium present. It is evident from the diagram that although individual tests vary greatly among themselves, due to inconsistencies in melting, handling, etc., there is a general decrease in the amount of carbon left in the alloy, as indicated by the straight line drawn, and this decrease is

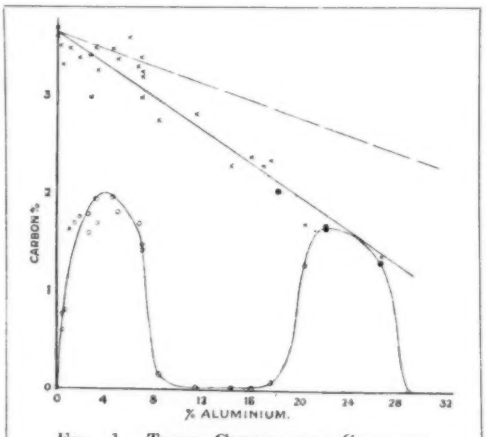


Fig. 1.—Total Carbon and Graphitic Carbon in Al-Cast Iron.

directly proportional to the amount of aluminium added. Of 3.7 per cent. carbon in the original iron there is only 1 per cent. left when 29 per cent. Al. has been added.

The dotted line shown in Fig. 1 indicates the theoretical curve produced by simple dilution of the iron with aluminium, and the difference between this and the curve shown must represent the loss of carbon as kish.

In the alloys contaning above 18 per cent. Al, graphite was precipitated as kish from the molten iron on the addition of aluminium. This kish occupied a large volume, and made the handling of the alloy very difficult.

Graphitic Carbon.

The curve in Fig. 1 shows the amount of graphitic carbon in the alloys, sand cast ½ in. square, the examination of which shows that there are two graphitic ranges in the series from 0 to 30 per cent. Al. The first, extending in the present case from 1 to 8 per cent. Al, has been recognised by all workers although given various limits of persistence, and is regarded as analogous to the graphitic range in silicon irons, which includes all the various grades of mottled and grey iron. In this case the curve reaches a maximum of 2 per cent. graphitic carbon out of 3.3 per cent. T.C. at 4 per cent. Al.

It is believed that the presence of the second graphitic range, shown as extending from 19 to 26 per cent. Al, has not been previously demonstrated. In this range the alloys become machinable and softer, and, in fact, revert to a truly graphitic state after passing through a region where all the alloys are very hard and brittle. This graphitic range is apparent in the curves of general properties—hardness, etc.

Above 26 per cent. Al, graphitic carbon disappears gradually, but the total carbon is not

determinable by the ordinary methods. The metal resists dry combustion, proving very refractory, and by wet methods hydrocarbons are evolved, involving loss of carbon or gas. A yellow phase is seen in freshly-fractured specimens, and on standing in the atmosphere for two or three days, this turns white and powdery. A smell of hydrocarbons is evolved, and alloys slightly higher up in this range gradually disintegrate. All of this suggests that aluminium single or double carbides are present, these reacting with moisture in the air to give alumina and hydrocarbons, causing in the meanwhile disintegration of the mass of metal.

Shrinkage.

Fig. 2 shows the pattern shrinkage of the alloys up to 30 per cent. Al, expressed as ins. per ft. Starting with the original iron, shrinkage first increases slightly, this probably being due to the effect of aluminium in deoxidising the metal. After this the curve falls, giving a dip corresponding to the first graphitic range in the series; this would be expected, as in the silicon-iron series shrinkage is proportional to the amount of combined carbon present. Above 6 per cent. Al the shrinkage curve rises continuously, and at 30 per cent. the alloys have the abnormally high shrinkage of 0.37 in./ft. This is comparable to the effect noted by Hague and Turner (10) in the case of irons with silicon: "The final contraction of the cold bar (washed iron with 19.5 per cent. of silicon added) was very marked, being $\frac{3}{8}$ in. on 12 ins."

The second graphitic range, 19 to 26 per cent. Al does not produce a minimum in the shrinkage curve, but rather the shrinkage increases rapidly at the beginning of this range, while the amount of graphitic carbon is increasing.

Hardness.

Fig. 3 shows the Brinell hardness of the alloys in this series. In shape this curve corresponds inversely to the graphitic carbon curve. The alloys about 12 to 14 per cent. show the maximum hardness and are very brittle. By Brinell test the alloys about 23 per cent. Al are softer than those around 5 per cent.; however, it is found that the former alloys are much the less machineable, since the constitution of these alloys is that of a metal carrying very hard crystals in a soft matrix, and the metal, therefore, rapidly destroys the cutting edge of tools.

Specific Gravity.

Determinations were made by Archimedes' principle on lengths of Keep's test bar, of about 1½ in., and with the skin ground off to a depth of about $\frac{1}{16}$ in. to remove surface defects.

A smooth curve is shown (Fig. 4) with a very marked inflection between 9 per cent. and 22 per cent. Al. This range corresponds to the range of persistence of the hard white phase shown in the micro-analysis map (Fig. 5), which range also corresponds broadly to the hard, brittle range referred to under graphitic carbon and hardness.

Above 22 per cent. Al the curve becomes a continuation of the original part of the curve, as indicated by the broken line. The straight line shown dotted on the curve is the theoretical specific gravity curve assuming complete mixture, without combination or precipitation of graphite, of the two components of the alloys.

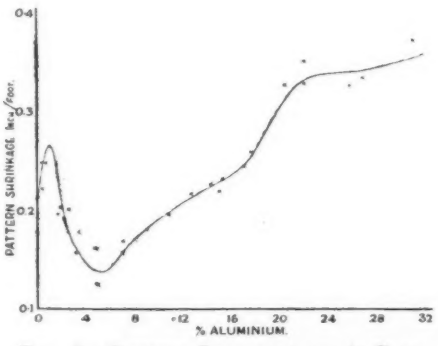


FIG. 2.—PATTERN SHRINKAGE IN AL-CAST IRON AS MEASURED BY KEEP'S TEST.

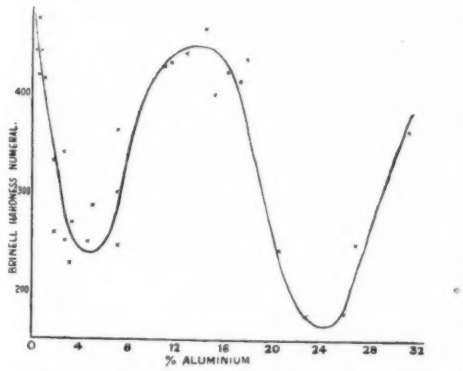


FIG. 3.—BRINELL HARDNESS OF AL-CAST IRON ALLOYS IN THE AS CAST CONDITION.

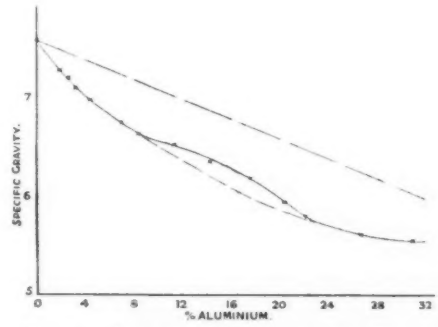


FIG. 4.—SPECIFIC GRAVITY OF CAST IRON CONTAINING ALUMINIUM.

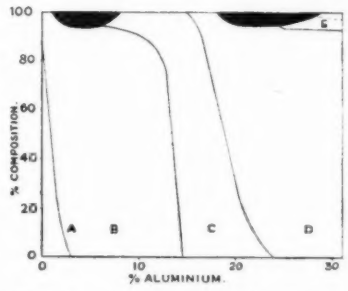


FIG. 5.—ALUMINIUM IN AMERICAN WASHED IRON.

Microscopic Analysis of the Series.

Fig. 5 shows in tabulated form the result of microscopic analysis of the series. This map has been drawn from specimens cut from the small Keep's bars in the "as cast" condition, examination being made in each case on the transverse section of the bar. The composition has been computed from the areas of the different phases seen on a section and in the photographs after a general examination of the specimens.

This map must be regarded only as a first approximation. Considerable difficulty was encountered in differentiating between different phases, and it will be realised that where solid solutions occur a phase may continuously change in aspect and properties. Again, the point at which a phase appears or disappears is so dependent on conditions of casting, and so on, which vary even from test to test in a series, that considerable variations in the map may subsequently

be encountered. The percentage volume of graphite is indicated, and this has been taken as 3.2 times the percentage weight by analysis.

All specimens were etched with picric acid when containing less than 10 per cent. Al. Above this amount of aluminium 10 per cent. nitric acid had to be used, picric acid producing no effect.

On adding aluminium, the pearlite constituent of the white iron, indicated as Phase b in the map, Fig. 5, increases regularly in bulk. This continues without any further change taking place up to 1 per cent. Al.

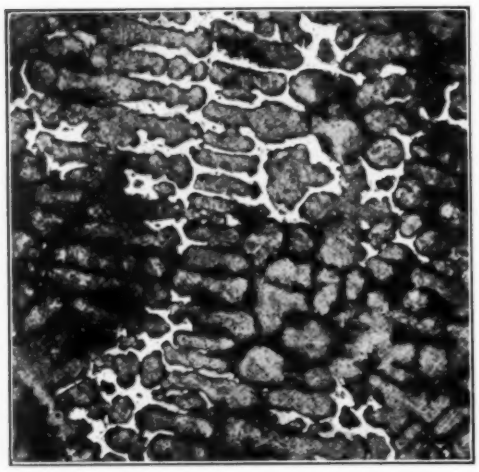


Fig. 6 × 150.

Above 1 per cent. Al, graphite becomes precipitated. The graphite seen throughout the series is in fine flakes, and finer than that normally associated with silicon irons. Up to 6 per cent. Al the pearlite increases in quantity at the expense of the austenite-cementite eutectic (Phase a, Fig. 6).

The pearlite is fine, and is not resolvable under the high power of the microscope. It may be stated, however, that in this range the pearlite remained resolvable in the sections of larger test bars, subsequently cast, where slower cooling conditions prevailed.

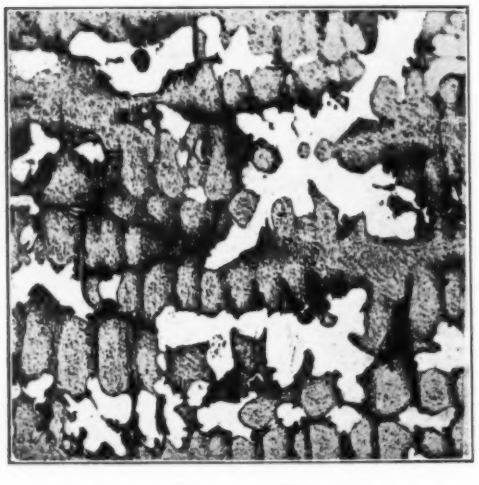


Fig. 7 × 150.

At about 7 or 8 per cent. Al a new phase appears (Phase c). This is seen as small white areas inside the light band at grain boundaries. This phase is exceedingly hard, and the limits of its existence mark the limits of the hard, brittle range in the alloys where carbon is taken back into combination. The development of this phase in the eutectic matrix is shown in Fig. 7—at 12.5 per cent. Al. The graphitic carbon has disappeared, suggesting that carbides are associated with this phase.

At 15 per cent. Al this hard white phase (Phase c) is seen in predominance, and this alloy lies very close to that possessing the maximum hardness and brittleness in the series. Fig. 8, at 17 per cent. Al, shows the development of the next phase, d, in the body of Phase c. This phase has a light golden colour on etching with 10 per cent. HNO_3. At 20 per cent. Al, graphite is seen precipitated in the body of this Phase d.

At 31 per cent. Al (Fig. 9), feathery needles and polygonal crystals are seen in the body of Phase d, and graphite has disappeared. These needles and crystals are both blue, and are decomposed by the atmosphere, leaving a white powdery

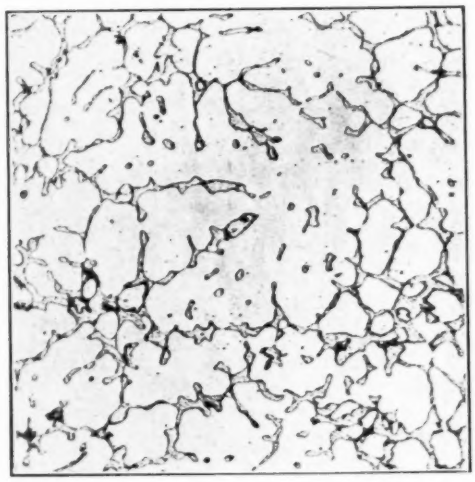


Fig. 8 × 150.

residue. This alloy gives off hydrocarbons in the presence of water or acids, and consequently it is inferred that these blue crystals and needles consist of true carbides.

In a Paper by Hague and Turner (10) on the influence of silicon on pure cast iron, photomicrographs are produced showing the growth of pearlite with increasing amounts of silicon; however, it is seen that in this case the iron is entirely pearlitic at 1 per cent. Si, a condition which does not exist until over 2 per cent. Al has been added to the same iron.

From the similarity seen here in microstructure and state of combination of the carbon between the silicon-iron-carbon series and the aluminium-iron-carbon series, as well as from the general analogy existing between silicon and aluminium in their chemical behaviour, it is believed that aluminium, like silicon, is soluble in the liquid austenite and precipitates excess graphite as kish when large amounts are added. In the lower ranges (1 to 5 per cent.) the aluminium probably ultimately appears as alumino-ferrite in the pearlite eutectoid. Similarities exist in the higher ranges, ferro-silicon with 50 per cent. of silicon having properties similar to

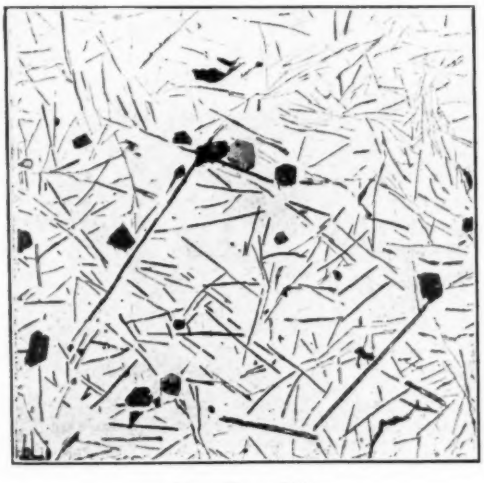


Fig. 9 × 150.

the 50/50 temper alloys first described. In each case here the added element is probably present as carbide, and both alloys decompose in the atmosphere. The similar influence on the shrinkage has been noted.

The rapid change of the iron from white to grey at about 1 per cent. of added element is seen with both aluminium and silicon; in the latter case this has been demonstrated by Hague and Turner (10).

SUMMARY.

It has been shown that on adding aluminium to a pure white iron containing no silicon a series of soft machineable grey irons is obtained between 1 and 8 per cent. Al, this series being analogous in general properties and microstructure to the grey irons in the pure silicon-iron-carbon system, aluminium acting less powerfully than silicon as a softener, 2 to 3 per cent. of aluminium being required to produce an iron comparable with one containing 1 per cent. Si, while the maximum percentage of carbon graphitised is 61 per cent. at 4 per cent. Al, as against 70 per cent. at 3 per cent. Si (10). This is in opposition to the results put forward by Melland and Waldron (6), but it must be remembered that silicon (0.24 per cent.) was present in the iron used in their research, and this, acting with the aluminium, would accentuate the influence of the latter on the carbon.

Graphite occurs in a finer form in the aluminium than in the silicon series. Above 8 per cent. Al a hard, brittle range is found extending up to 18 per cent. Al. In this range the carbon is all combined. Above 18 per cent. Al the alloys soften again, and graphite is precipitated, giving a second graphitic range from 18 to 25 per cent. Al. Above 25 per cent. Al the alloys become unstable in the atmosphere.

This work has been performed in the Metallurgical Department of the University of Birmingham, under Professor T. Turner, whose interest and assistance the author wishes gratefully to acknowledge.

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Spun-Sorbitic Centrifugal Castings.

A new application of the Hurst-Ball centrifugal process has been introduced, and patents have been applied for. The castings produced by this process have received the appellation "Spun-sorbitic." Spun-sorbitic castings are specially low-silicon cast iron, having the eutectic requirements of combined carbon in the pearlitic or the very finely divided pearlitic or sorbitic form. They are centrifugal castings, and possess all the advantages of the exceptionally fine-grained structure of centrifugal castings. In this respect they are thought to be superior to all other sand-cast pearlitic cast iron.

Spun-sorbitic castings can be produced embodying ports, waterways, bosses, flanged and belts. The chemical composition of the material is as follows:—C.C., 0.97; Gr, 2.03; S, 1.31; Mn, 0.42; S, 0.11; and P, 0.34 per cent..

It is interesting to note that a number of castings made by this process will be on view at the forthcoming Exhibition at Olympia.

Random Shots.

Considerable importance must be attached to the forthcoming introduction of the eight-hour day as applied to certain classes of workers in the German heavy iron and steel industry. It is actually a reversion rather than an introduction, since in the early post-war years the 48-hour week was virtually in force throughout the iron and steel works of Germany. In 1923, however, after the Ruhr troubles, there was a voluntary agreement on the basis of a temporary 10-hour shift.

* * *

The new move, which comes into force on January 1, 1928, and which will apply only to those "under the direct influence of heat, dust, and poisonous gases," will, it is calculated, affect about one-fifth of the 200,000 men in the West German iron and steel industry. The employers estimate that the change from two shifts of ten hours to three of eight hours will demand 18,000 extra men, but the workers claim that only 9,000 will be needed, and that the cost will be more than covered by the saving effected on the overtime at present being paid on the ninth and tenth hours. We in England will watch the effects of the new move closely, since it appears likely that German producers will at last be working on something like level terms with ourselves, though they will still be working through the week-end, with its consequent economies.

* * *

The suggestion that the Paris Convention should prove international in character is amply borne out by the list of the contributors of Papers, which has now been published. Besides a number of French members, they include Belgian, Italian, American, Czecho-Slovak, and British "conférenciers."

* * *

If you are still in need of holiday pastimes—*we* are back again at work, but there are idlers in every camp—may we commend to your notice the admirable series of general knowledge questions at present appearing in many sections of the Press. One is tempted to speculate on the origins of this fashion. The cross-word, we are told, is dead as a doornail—probably from over-work. Can it be that the great British public has at last been roused to a sense of its responsibilities, that its every moment of leisure now goes in the study of encyclopædias and the racking of brains over long-forgotten data from the schoolroom? Or—dare we whisper it?—has the said great British public merely observed that there are handsome prizes to be won?

* * *

In either case, it is a splendid pastime. Of course, if the answers are given on the next page it is easy enough, but more often they are held up until next day or next week or next issue—and then the real brainwork comes in. The important thing, after all, is not so much to know the right answer as to convince the assembled company that you do—which may involve confiscating the tell-tale issue with the answers in case of an unfortunate error of judgment.

* * *

We have no intention of being left behind in this any more than in any other direction. We offer no prizes, however. Your only spur must be the disinterested love of knowledge for its own sake. And don't send us the answers—we haven't the least intention of looking at them if you do.

Here are the questions:—

(1) Give an apprentice's main job during his first foundry year.

(2) What is the difference between a riser, an early riser, and a knocker-up?

(3) Give the difference between a runner and a non-starter.

(4) What is superheating, and what was the first known instance of a foreman disappearing by spontaneous combustion?

(5) Where does the plumbago, and why? If not, why not?

(6) What happens in the long run to a short-run casting?

N.B.—If you want the answers you'll have to supply them yourself. *We* don't know them.

MARKSMAN.

Correction of Cupola Operation by Means of Cupola Temperature Recorder.*

By H. W. Dietert,† Detroit, Michigan.

The cupola temperature recorder consists of three parts, the hood, a thermo-couple and the recorder. In Fig. 1 is shown a section of a cupola spout. The hood, consisting of a cast-iron frame, is shown setting over the spout and supported by means of suitable fingers resting on the iron frame of the spout. The object of the hood is to collect the gases rising from the molten iron stream, and also to form a constant temperature compartment for the gas collected. The maintenance and operating care is very small, which makes it a practical shop installation. The United States Radiator Corporation have six of these recorders in operation and find them a great aid in the standardisation of cupola operation and iron temperatures. The electrical thermo-couple with its bare tip responds to variation of temperature of the iron and causes the recorder to make a permanent record of the iron temperature throughout the heat.

Applicable to Either a Continuous or Intermittent Flow of Iron.

The cupola recorder may be adapted to either a continuous or intermittent flow of iron from cupola. In adapting the recorder to an intermittent operated cupola, the hood is mounted on

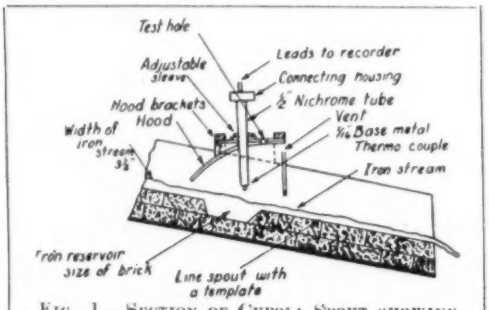

Fig. 1.—Section of Cupola Spout showing Assembly of Hood and Thermocouple over Iron Reservoir for an Intermittent Flow of Iron.

the cupola spout as shown in Fig. 1. One brick is left out of the bottom of the spout just beneath the hood to form an iron reservoir as shown in Fig. 1. This reservoir of iron will stay molten for about ten minutes, and in this manner the recorder will quickly respond to flow of molten iron when the cupola is tapped. The recorder will normally come to correct reading within 30 sec. when once heated. For continuously-operated cupolas it requires on an average 12 min. for the recorder to come to correct reading.

The thermo-couple is suspended 2 ins. above the iron stream. When a proper hood is used, a variation of plus ½ in. from the standard 2 ins. will cause the recorder to read 12 deg. low. This is much closer than is required in actual practice. The 2 ins. is maintained by lining the spout with the aid of a template and the use of a test wire occasionally to check the distance. The life of the thermo-couple is from three to four months, and it is easily and cheaply replaced. A specially-designed cupola head is used to allow for repairing the couple wire at least three times, thus giving a total life of nine months to one couple wire.

Conclusions.

As a result of several years' experience, the following conclusions have been drawn:—

(1) An overburnt coke charge will show up as a drop in the iron temperature after about three-quarters of an hour of operation.

(2) An underburnt coke bed will cause the first iron to come at a low temperature for as much as 30 minutes, depending on how underburnt the coke bed was.

(3) The idling of a cupola either by reducing the blast or by closing the blast entirely will decrease the iron temperature.

(4) An excessive reduction of the coke bed or coke charge will produce a very irregular temperature line.

(5) A booster coke charge during the heat will increase the iron temperature when the booster reaches the melting zone.

(6) When charging is stopped and charges in cupola go down the air blast must be decreased for pressure blowers to give a uniform temperature at the end of the heat.

(7) A comparison of the volume meter reading and the temperature chart reading proves that correct air volume is required to secure desired temperatures.

(8) A comparison of temperature charts between hand- and mechanical-charged cupolas indicates that mechanically-charged cupolas will give greater uniformity of temperature over an extended period than a hand-charged cupola.

(9) When insufficient coke is charged the temperature will raise and lower for each charge melted. There is no exact optimum coke charge which may be applied to all cupolas. The optimum coke charge is dependent upon the quality of coke, design of cupola, charging methods, size of pigs and scrap charged, and the desired temperature of the iron.

(10) A low coke bed, or a coke bed that has burnt to a low level, will show up on the temperature chart as a sudden jump of at least 100 deg.

(11) Where each iron and coke charge are not weighed, a greater coke charge must be used to secure a uniform temperature to allow for fluctuations in charging.

(12) A uniform temperature chart requires a uniform melting zone. Whenever the melting zone changes, a change is immediately noted on the chart. The quality of the iron will also change.

* Abstracted from a Paper read before the American Foundrymen's Association.

† Engineering Dept., United States Radiator Corporation.

Dating of Patents.

Report of Committee.

In May, 1926, the Board of Trade appointed under the chairmanship of Mr. J. Whitehead, K.C., a Committee whose terms of reference were:—"To inquire into and report whether any, and, if so, what change is desirable in the practice of the United Kingdom of:—(*a*) Dating and sealing patents applied for under Section 91 of the Patents Acts, 1907 and 1919, as of the date of the application in the foreign State. (*b*) Dating and sealing other patents as of the date of application in the United Kingdom as provided by Section 13 of the Acts." The following is a summary of the Committee's conclusions.

(1) No change is desirable in the existing practice in the United Kingdom as to the dating and sealing of patents.

(2) If, however, for any reason, it should be considered expedient to make a change in the British practice, the Committee recommend that such change should be limited to an alteration in the term of the patent as outlined in system (C) in the report. Under that system, the fixed portion of the term or monopoly period of the patent in respect of any application, whether dated under Section 13 or Section 91 of the Acts, would commence from the date of filing of the complete specification. Consequently, the period between the date of application in the country of origin and the date of application in the United Kingdom would be added to the monopoly period in the case of an application under Section 91 of the Acts.

(3) Such a change should not be made unless the agreement of the other Convention countries is obtained to the abolition in such countries of third-party rights, and rights of personal possession, arising after the date of application in the country of origin, and possibly also to concessions in respect of other matters unsuccessfully brought forward by the British delegates at the Washington and Hague Conferences of the International Union, and referred to in the proceedings of those conferences.

(4) If such change is made, the necessary amending legislation might also provide:—(*a*) For the repeal of Section 91 (3) (*a*) of the Acts, under which the specification filed with an application under Section 91 of the Acts may be laid open to public inspection twelve months after the date of application in the country of origin; and (*b*) for the extension of the period for filing a complete specification from nine months (with extension ten months) to twelve months with no extension.

Castings for Diesel Engines.

By Harukichi Matsuura.

Introduction.

The following is a report of an investigation carried out at the Niigata Engineering Works, which makes the Mirrlees type of Diesel engine in Japan. It was presented to the Japanese Society of Mechanical Engineers.

The range of temperature to which Diesel engine cylinders are subjected may vary considerably according to the design and condition of working. Roughly speaking, it reaches a maximum of about 600 deg. C. under normal conditions, associated with a pressure of about 500 lbs. per sq. in. An abnormal temperature rise, however, may occur when working under overload conditions, or when some breakdown happens to the cooling water arrangements, then it may reach over 1,000 deg. C., where the spontaneous combustion of fuel oil takes place. A piston temperature chart taken from the M.A.N. Company's common type 70 B.H.P. engine was given on page 475 of Vol. 30 of THE FOUNDRY TRADE JOURNAL. The primary requirements for the iron to be used is that it must be sufficiently reliable to maintain a safe predetermined working stress even at high temperatures, and also be sufficiently tough to eliminate heat cracking due to severe temperature difference. Actually, an iron showing the least loss in strength with increasing temperature is required. Secondly, good resistance to wear and maintenance of shape and dimension under prolonged heating effect are similarly necessary.

The Strength of Cast Iron at Elevated Temperatures.

Tensile tests were made on cast iron at various temperatures ranging from atmospheric up to 700 deg. C. Three samples A, B, C, having the composition shown as Table 1, were selected, and

TABLE I.—*Tensile Strength of Cast-Iron at Elevated Temperature.*

Temperature, deg. C.	Time of heating, Mins.	Tensile strength, ton/sq. in.			Per cent. of C.C. after heating.	
		A.	B.	C.	A.	B.
Room	30	17.4	13.1	10.7	0.83	0.66
320	,,	17.4	—	—	0.82	—
350	,,	17.0	—	—	0.84	—
400	,,	17.0	12.7	10.6	0.83	—
450	,,	16.8	12.3	—	0.82	—
500	,,	16.4	12.3	9.6	0.81	—
550	,,	14.5	9.8	8.0	0.80	0.71
600	,,	12.4	7.6	5.8	0.81	0.64
650	,,	10.4	—	—	0.80	—
700	,,	7.6	3.8	—	0.77	0.55

Initial composition of test pieces.		Gr. %	C.C. %	Si. %	Mn. %	P. %	S. %
	A.	2.47	0.83	1.4	2.10	0.16	0.05
	B.	2.83	0.66	2.00	1.30	0.61	0.07
	C.	3.44	0.54	2.54	1.10	0.84	0.06

they were annealed for one hour at 600 deg. C. to relieve casting stress before testing. The specimens were machined to 0.656 in. dia., and were 8 ins. long. All the specimens were held at a constant temperature for 30 minutes before pulling, and were carefully broken with same rate of loading on all specimens. The decrease in strength of cast iron occurs with the increase in temperature to which it is heated. This decrease, however, is not so strongly marked until about 500 deg. C. is reached, when a distinct lowering is shown. It can be presumed, therefore, that cast iron may be used safely up to 500 deg. C. so far as tensile strength is concerned, but taking it at 10 ton per sq. in., then cast iron A will be found safe in its strength even at 650 deg. C., while those of B and C fail before they reach 550 and 500 deg. C. respectively.

Thus, different irons have different safety temperatures, corresponding to a certain specified strength, but as the duration of heating the test for a longer period the lowering in strength becomes proportionally greater, resulting in a further reduction in the safety-temperature range utilisable.

Cause of Loss of Strength.

From micro-sections taken from the specimens of A and B, broken at both room temperature and at 600 deg. C. respectively, the author failed to find any outstanding difference, nor did the carbon content, as shown in Table 1, throw much light on the subject. Consequently it is thought that the decrease in strength can be attributed to the physical influence put upon the intercrystalline grain boundaries due to the deformation of so-called amorphous cement. The cohesion of grain boundaries may be seriously affected by the heat-stress, induced by the difference of coefficient of expansion between iron and graphite. The reduction in the intercrystalline cohesion of the metal is the result of the characteristic nature of iron becoming brittle at high temperature.

Below 600 deg. C. there is little chemical change, as shown in Table I, therefore it can be rightly attributed to physical effect. The microstructures of A and B, which were broken at 700 deg. C., disclose a change in the pearlite structure, which would be expected from the lower combined carbon, as shown in Table I. But even in this case the reduction of intercrystalline cohesion would be greater, and will cause increased decomposition of pearlite at the Ac_1 point. The decomposition of iron carbide is a function of time and temperature, and will occur even at much lower temperatures than Ac_1, if the heating is at all prolonged.

When working temperatures exceed Ac_1, pearlite changes into austenite, which governs the strength of cast iron, the higher the temperature beyond Ac_1 and the longer the time of heating the more the grain growth of austenite will occur. Consequently the decrease of intercrystalline cohesion will be much more rapid.

Wearing Qualities of Cast Iron.

Grey cast iron possesses a better wearing quality than steel owing to the presence of graphite, which acts as lubricant, and also to the presence of hard cementite and phosphide eutectic embedded in the softer matrix which resembles antifriction metal. If that be the case, cast iron having graphite in quantity and of large size should give a better wearing quality, but it does not necessarily follow. The greater the quantity of graphite, the lower is the degree of coefficient of friction, but where it is of the large straight variety it renders cast iron weak, because of the lack of the continuity of grains. Consequently, when sliding motion takes place under heavy load at high speed, especially under the effect of high-pressure gases, an injurious effect on sliding surface is brought about by the deformation of crystalline grains, thus the wearing quality in such cast iron will be definitely lowered.

On the other hand, the wearing quality of cast iron is influenced by the degree of fineness of machining. When the structure is soft and open-grained, it is very difficult to obtain a fine polished surface, thus it would result in material of poor wearing quality.

In one experiment a number of ring-shaped specimens were taken from actual cylinder castings of an internal-combustion engine, and machined all over to definite dimensions and their bursting strength and hardness were measured. A number of machined cast-iron discs of definite size and of almost equal quality were brought into contact with the inner speed under a given load which was put on the ring, and also in lubricated condition, and after a given length of time of running, the loss of weight of ring were measured.

Recently Mr. Horikiri, of Osaka Technical Laboratory, has reported on his experiments of wearing qualities of cast iron, with the result that the least amount of wear could be associated with cast iron of all-pearlite matrix. According to Ludwig Loewe the rate of wear rapidly diminishes with increased tensile strength, and indicates that

for wearing purpose a tensile strength 14 tons per sq. in. or over is called for.

Cast iron of high tensile strength or of pearlite structure should have good wearing quality in general, apart from the conditions encountered at high temperature. Judging from the fact that cast iron decreases its strength at high temperature, owing to the reduction of intercrystalline cohesion in conjunction with the decomposition of pearlite. In actual engine cylinders, as the result of the reduction of intercrystalline cohesion, vibration would cause a gradual loosening of the grains which action would be accelerated by gas pressure, thus injuring the surface.

When grey cast iron is subjected to heating and cooling at high temperature in the presence of air, the so-called growth phenomenon takes place owing to the oxidation of silico-ferrite and graphite, resulting in an increase in volume, a decrease in hardness and strength, and probably cracks at the skin. This phenomenon can take place below 600 deg. C. The cause of cracking as well as seizing which occur in cylinders is not so much due to growth of materials as to heat stress consequent upon temperature differences. According to Prof. Mellanby, cast iron having a high resistance to growth would also have good wearing qualities.

Cast Iron for Diesel Engine Work.

Cast iron possessing a high order of intercrystalline cohesion at high temperature should be encountered in an iron having a low amount of graphite and other impurities, and a well interlocked crystalline grain, or in other words, it will be an iron of high tensile strength. The author, therefore, recommends cast iron of the highest tensile strength, provided that other mechanical properties are not adversely influenced because the safe working temperature will be correspondingly elevated with such an iron.

The actual temperature of cylinder parts in Diesel-engine working is considered about 500 deg. C. Then, if safe working stress is assumed to be 3,500 lbs. per sq. in., the cast iron having tensile strength of 15.6 ton per sq. in. will have a safety factor of 10 at ordinary temperature, but it will be decreased to 8 at 500 deg. C., as is seen in Table I. Therefore, to keep a safety factor of 10 at 500 deg. C., the tensile strength of cast iron at ordinary temperature should be at least 17 tons per sq. in. Where heat stress is present, the lowering of the safety factor will be considerably greater.

Graphite, especially when it is large in amount, or coarse in form, will make cast iron weak in structure by spoiling the continuity of crystalline grain. Therefore high-tensile cast iron should consist of an all-pearlite matrix and fine well-curved, *i.e.*, rosette-like graphite, or the so-called Kikume structure of Dr. T. Ishikawa. Furthermore, rate of cooling exerts a powerful influence upon the condition of carbon, especially during the freezing of the molten cast iron, as this has a profound influence on the resultant grain size condition after solidification and upon the form of graphite and the development of pearlite.

By rapid cooling through the solidification range, the nuclei of the primary austenite will be increased and by slow cooling after freezing the distribution of free graphite will become fine and moreover, the development of pearlite will be completed, thus giving a cast iron of great strength. Thus, cast iron having higher melting point and shorter solidification range will have the greater strength. On this point, further researches are now carrying out in the author's laboratory.

Cast Iron showing Low Decomposition of Pearlite at High Temperature.

Pure iron carbide is unstable and will decompose into ferrite and temper carbon at high temperature. But in cast iron, iron carbide is somewhat impure, so the properties at high temperature will differ from those of pure iron carbide. Dr. Hatfield has shown that the presence of silicon renders the carbide less stable, and manganese and sulphur more. However, 3.0 per cent manganese and 0.45 per cent. sulphur in the presence of 0.9 per cent. of silicon do not render the carbide completely immune from dissociation.

According to Dr. Carpenter, manganese and sulphur in cast iron retard growth and when a cast iron containing 2.66 per cent. of T.C., 0.58 per cent of Si, 1.64 per cent. of Mn, and 0.1 per cent. of S and P, was heated to 850 to 900 deg. C. for 4 hrs. and cooled, there occurred a small decrease in volume, whilst the amount of decomposed carbide was only 9.6 per cent.

The stability of carbide at high temperature is increased by lowering the silicon content and increasing manganese and sulphur content in cast iron. Sulphur when greater than 0.1 per cent. has an injurious effect on cast iron, though it may increase heat resistibility of cast iron.

Manganese has a beneficial effect on cast iron and in ordinary cast iron even 3.0 per cent. of it does not make iron too hard to be machined. Manganese changes the form of pearlite to sorbitic phase and thus raises the tensile strength. Moreover, manganese has a good effect forming glazed surface in the sliding parts of machinery and consequently increases the resistance to wear.

Properties of High Manganese Semi-Steel.

A number of 25 per cent. semi-steel cast-iron samples containing from 0.66 to about 4 per cent. Mn were melted in graphite crucible. From the melts bars 1¼-in. dia. and 8 in. long, and others 1¼ in. sq., by 16 in. long, were cast into dry-sand vertical moulds; when completely cold tensile test-pieces of 0.533 in. dia. and 2 in. gauge length and transverse test pieces of 1 in. sq., and 14 in. long were prepared. The chemical compositions and physical properties are shown in Tables II and III.

Table II.—*Composition of Semi-Steel Samples.*

No.	Composition, per cent.					
	Gr.	C.C.	Si.	Mn.	P.	S.
1	2.40	0.49	1.65	0.66	0.111	0.034
2	2.25	0.66	1.62	1.62	0.118	0.034
3	2.37	0.56	1.61	1.88	0.111	0.028
4	2.26	0.69	1.62	2.33	0.138	0.030
5	2.12	0.78	1.55	2.54	0.121	0.031
6	2.19	0.98	1.72	3.17	0.099	0.032
7	2.29	0.97	1.64	3.87	0.103	0.031

Table III.—*Physical and Mechanical Properties of Semi-Steel.*

No.	Tensile strength, ton/sq. in.	Transverse strength, lbs.	Hardness.		Specific gravity.
			Brinell.	Shore.	
1	16.14	3,705	199	28	7.22
2	16.90	3,800	212	34	7.30
3	17.32	3,880	215	34	7.30
4	17.40	3,890	215	37	7.28
5	17.90	3,955	220	38	7.31
6	18.40	3,915	238	38	7.31
7	17.16	3,420	245	40	7.25

From these it will be seen that the strength of semi-steel having total carbon about 3.0 per cent. and silicon 1.6 per cent. was generally improved by increasing its manganese content from 0.66 per cent. up to about 3.0 per cent, but with more than 3 per cent. Mn brittleness showed up inducing a decrease in tensile strength.

Additionally high manganese semi-steels having more than 3.0 per cent. Mn were found to be too hard to machine.

The micro-structure of semi-steel with 3.87 per cent. Mn revealed the presence of considerable amounts of free cementite, whilst in those containing from 0.66 to about 3.0 per cent. Mn. free cementite was absent, but there was strong tendency for the pearlite to assume the sorbitic form. In the author's opinion, the maximum amount of manganese desirable in semi-steel containing about 1.6 per cent. of silicon is a maximum of 3 per cent.

To ascertain the influence of manganese upon the stability of pearlite of cast iron, several types of semi-steel were annealed for one hour at 750 deg. C., and then cooled in straw ash. The results of these experiments are shown in Table IV.

The mechanical and physical properties after repeated heating and cooling were examined. In this ten transverse specimens were placed into a steel cylinder 6 in. dia. by 20 in. long, one end of which was sealed. The bars were packed with

fine silica sand, and the open end was effectively sealed. This cylinder was heated in an oil furnace to 880 to 910 deg. C. for 3 hrs. It was then taken out of it and cooled in air. After every tenth heat treatment, a number of specimens

TABLE IV.—*Mechanical Properties of Semi-Steel after Annealing for One Hour at 750 deg. C.*

No.	Tensile strength, ton/sq. in.			Brinell hardness.			C.C., per cent.	
	Before annealing.	After annealing.	Per cent. of reduction.	Before annealing.	After annealing.	Per cent. of reduction.	Before annealing.	After annealing.
1	16.1	10.8	32.9	199	126	36.7	0.49	0.27
2	16.9	14.0	17.2	212	174	17.9	0.66	0.41
3	17.3	15.2	12.1	215	179	16.6	0.56	0.53
4	17.4	16.05	7.8	215	183	14.8	0.69	0.61
5	17.9	17.25	3.6	220	190	13.6	0.78	0.76

were taken out of the steel cylinder and their physical and mechanical properties tested. The tensile test pieces were machined from the broken transverse specimens. The amount of growth was measured by the increase in diameter of the tensile specimens, which were originally charged in the cylinder together with transverse test specimens.

The results are given in Tables V to VIII. These show that the increasing manganese content

TABLE V.—*Transverse Strength of Semi-Steel after Repeated Heating and Cooling.*

No.	Transverse strength, Lbs.				
	Before heat treatment.	After 10th heat treatment.	After 20th heat treatment.	After 30th heat treatment.	After 40th heat treatment.
1	3,705	2,800	1,920	6,155	1,590
2	3,800	3,190	2,315	1,990	1,830
3	3,880	3,150	2,360	2,100	1,940
4	3,890	3,215	2,480	2,260	2,060
5	3,955	3,295	2,790	2,320	2,100

TABLE VI.—*Tensile Strength of Semi-Steel after Repeated Heating and Cooling.*

No.	Tensile strength, ton/sq. in.				
	Before heat treatment.	After 10th heat treatment.	After 20th heat treatment.	After 30th heat treatment.	After 40th heat treatment.
1	16.14	11.82	9.24	4.91	4.44
2	16.90	15.78	14.08	10.86	5.80
3	17.30	16.32	14.25	12.04	6.80
4	17.40	16.46	15.74	14.08	7.96
5	17.90	17.29	17.02	16.57	11.00

TABLE VII.—*Hardness of Semi-Steel after Repeated Heating and Cooling.*

No.	Brinell hardness.				
	Before heat treatment.	After 10th heat treatment.	After 20th heat treatment.	After 30th heat treatment.	After 40th heat treatment.
1	199	147	98	90	87
2	212	172	126	111	99
3	215	181	137	118	105
4	215	183	151	133	111
5	220	197	159	139	112

TABLE VIII.—*Growth of Semi-Steel after Repeated Heating and Cooling.*

No.	Change of diameter. Original diameter = 1.			
	After 10th heat treatment.	After 20th heat treatment.	After 30th heat treatment.	After 40th heat treatment.
1	1.0407	1.0763	1.0891	1.0908
2	1.0319	1.0741	1.0769	1.0844
3	1.0266	1.0651	1.0800	1.0842
4	1.0245	1.0533	1.0729	1.0844
5	1.0244	1.0618	1.0694	1.0720

in semi-steel containing about 3.0 per cent. T.C. and 1.6 per cent. Si arrests in a marked degree the rate of loss of strength and hardness, as well as the rate of growth when subjected to the repeated heating and cooling. The best results were obtained in the semi-steel containing 2.54 per cent. of Mn.

For example, the percentage of decrease of strength of No. 5 semi-steel (Table II) after the 40th heat treatment, *i.e.*, 120 hours severe annealing is 38.5 per cent., while the same percentage of decrease occurred after only 45 hours annealing in No. 1 semi-steel, as may be seen from Table VI. Generally speaking the heat-resisting property of No. 1 semi-steel is 2.5 times greater than that of No. 5, as shown by their tensile strength. Moreover, the heat-resisting properties of No. 5 semi-steel were increased by 2 to 2.5 times as measured by its transverse strength, hardness and amount of growth.

Thus high manganese semi-steel appears to be suitable for such parts of castings as Diesel engines, as they maintain higher strengths even after repeated heating and cooling.

In cupola practice it is very difficult to work satisfactorily with an iron of total-carbon under 3 per cent., and great precautions are necessary. Whilst it is desirable to obtain an iron of low total-carbon for certain castings, it remains very difficult to make sound castings, especially with an iron of low total-carbon associated with low-silicon content in ordinary cupola practice. On the other hand, when silicon is low, the amount of manganese must not be increased beyond certain limits. A workable ratio between total-carbon, silicon and manganese contents may be established for the purpose of obtaining good sound castings. Mr. Cook recommends the maximum amount of phosphorous for this type of casting to be 1.0 per cent., but the author thinks it is undesirable to exceed 0.3 per cent.

From experience it can be stated that high manganese and low phosphorous semi-steel provides a suitable mixture for Diesel-engine castings, and the following formula was devised to reproduce the most suitable quantities of total carbon, silicon and manganese for this purpose.

$$Si = \frac{3 \text{ to } 3.5}{T.C. - 1} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (A)$$

$$Mn = (3 \text{ to } 3.5) - \frac{1}{Si - 0.6} \quad \ldots\ldots\ldots \quad (B)$$

where the respective elements are expressed as percentages. For example, when T.C. = 3 to 3.5 per cent., then Si = 1.2 to 1.75 per cent., and Mn = 1.3 to 2.6 per cent. When the T.C. is low, the Si is to be increased, and where the T.C. is high, the Si is to be decreased. Again if the Si is low, then Mn is to be lowered and *vice versa*.

Great care is necessary to obtain good results from this type of iron, as it has a higher melting point and shorter freezing range. It requires a higher speed of running, using larger gates, runners and feeding heads, otherwise, iron shot, hard spots, shrink hole, etc., may occur. The casting temperature, from the author's experience, should be as high as possible.

The strengthening effect of manganese upon the cast iron seems to be due to the fact that the form of pearlite changes to sorbitic, and the retarding effect of the manganese upon the decomposition of pearlite carbide at high temperature may be due to the greater stability of double carbide $(Fe\ Mn)_3C$ at high temperature compared with single carbide Fe_3C. The heat formation of $(Fe\ Mn)_3C$ is probably greater than that of Fe_3C, because Mn_3C evolves 10,400 cals., while Fe_3C 8,460 cals.

In conclusion, the author would like to express his sincere thanks to Prof. K. Tawara for giving many valuable suggestions, and to Mr. Y. Saito and Mr. K. Okamoto who gave considerable help in carrying out these experiments.

British Association for the Advancement of Science.—This Association has issued the preliminary programme of its forthcoming Leeds meeting to be held from August 31 to September 7 inclusive. Further particulars as to membership, etc., may be obtained from the office of the Association, Burlington House, London, W.1.

A Critical Analysis of Cupola Practice from the Angles of Coke Combustion and Size of Charges.

By W. E. Dennison.

It is usually stated that the air supply of a cupola should be at the rate of 30,000 cub. ft. per ton of iron melted. As the function of the air is to provide oxygen for the combustion of the carbon of the coke, such a statement manifestly needs qualification. The coke to iron ratio may vary considerably, say from 1 to 6 to 1 to 14, so that if the air blown is based on the melted tonnage it is evident that the cupola-melting zone atmosphere may vary considerably. As the practice of blowing air to the cupola at the above-mentioned rate is very general, we will examine its quantity relation to the coke supply.

The following combustion and other data is essential to an understanding of cupola melting:—

(1) Each lb. of C. requires for its complete combustion to CO_2, 2.67 lbs. of O.

(2) Air contains 23.2 per cent. of O. by weight, hence the weight of air required per lb. of C. is 2.67 ÷ 0.232, which equals 11.5 lbs.

(3) One pound of air at normal temperature and pressure occupies a volume of 13.15 cub. ft., hence the volume of air required for the complete combustion of 1 lb. of C. is 156.5 cub. ft.

(4) The products of complete combustion of 1 lb. of C. is 11.5 + 1 = 12.5 lbs., of which 8.83 lbs. will be N., and 3.67 lbs. C.D.

(5) The calorific value of C. to CO_2 is 14,540 B.T.U. per lb.

(6) The theoretical maximum temperature rise of the gases is obtained by dividing the heat of combustion by the number of heat units required to raise the total products of combustion one degree. The specific heats and the weights of gases are the factors.

The following shows the calculations involved in the determination of the theoretical maximum temperature rise attained by the perfect combustion of C.:—

8.83 (lbs. N.) × 0.2169 (S.H.)	= 0.7953
3.67 (lbs. CO_2) × 0.2438 (S.H.)	= 2.1527
B.T.U. required	= 2.9480

Therefore, 14,540 ÷ 2.948 = 4,932 deg. Fah., or 2,722 deg. C. theoretical maximum.

Of course, such a maximum temperature ignores loss by conduction and radiation to the metal and furnace lining. One has to visualise 12.5 lbs. of gas at X deg. °C., and say 11 lbs., or iron at a preheated temperature of Y deg. C. The temperature, as far as the mechanics of combustion will allow, will tend to equalise so that the higher the theoretical maximum temperature X, that is the more perfect combustion, the higher will be the temperature of the melt. Other reactions, of course, enter into the heat balance, but the above statement holds true.

The writer insists that the conditions of cupola melting lend themselves to good combustion practice, and that either coke or air excess over the theoretical balance that is required to give as near a neutral atmosphere as practical, will cause a decrease of the maximum temperature.

(7) A normal foundry coke has a C.C. of 88 per cent. The volume of air needed per lb. of coke will be 156.5 × 0.88 = 138 cub. ft.

(8) Thus a delivery of 30,000 cub. ft. of air is sufficient for the perfect combustion of 30,000 ÷ 138 = 217 lbs. of coke.

(9) It follows that on the basis of 30,000 cub. ft. of air per ton of iron melted, a coke ratio of 1 in 10 gives the theoretical conditions for perfect combustion.

(10) The foregoing has ignored the endothermic reaction which takes place when CO_2 comes in contact with incandescent or partially incandescent carbon. This does not occur until a depth of 16 in. has been traversed even under natural draught conditions, providing the air supply is sufficient. Boiler combustion tests made with forced draught, which is analogous to cupola conditions, have shown that reduction of CO_2, as expressed by the reaction $CO_2+C=2CO$, does not occur until at least 24-in. fuel depth has been exceeded, even when the air supply is in only small excess. Thus it is reasonable to conclude that under the most economical conditions of cupola melting, reduction of CO_2 to CO does not occur to any but a small extent until higher in the shaft than the melting zone. The amount of reduction will cause a diminution of the carbon content of the higher coke charges, but not seriously enough to upset the previous calculations. To a certain extent the reaction is reciprocal, a deposition of C. occurring in the higher metal charges.

(11) The C. absorbed by the iron accounts for a very small percentage of the coke charges. For instance, with a coke charge one-tenth of the iron charge, and an increase of C. in melting of 0.20 per cent., about 1/50th of the coke charge has been accounted for.

(12) Making an arbitrary allowance of C. for Points (10) and (11), it has been made clear that 1 lb. of 88 per cent. C. coke should, on the basis of 30,000 cub. ft. of air per ton of iron, melt from 9 to 10 lbs. of iron. Further, the maximum temperature will be attained under these conditions. Any increase of coke over this proportion is dissolved either by the CO_2 or Fe, certainly in both cases to no useful purpose, and possibly in both cases detrimentally, *i.e.*, in the first case by lowering the temperature of the gases, and in the second case, depreciating the quality of the metal by the excessive absorption of C., and consequent high graphitic separation.

The foregoing is really an explanation of just what 30,000 cub. ft. per ton of iron melted means. It is rather an indirect, but owing to prevailing practice, a necessary way of studying the matter.

Fig. 1 shows graphically the theoretical atmosphere with various fuel ratios when the basis of air supply is the erroneous but popular 30,000 cub. ft. of air per ton of iron melted.

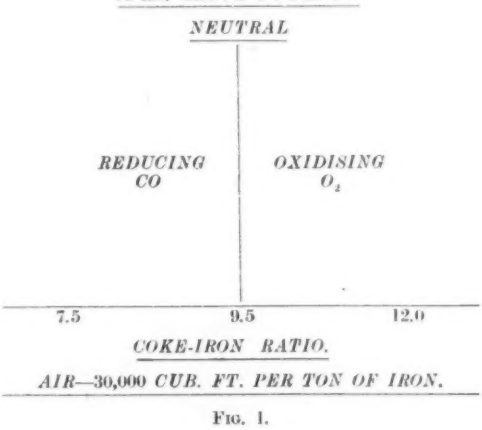

Fig. 1.

It is not suggested that, assuming the blower capacity has been fixed on the above basis, and that the coke charges have been based on Point (8) of this article (220 lbs. coke per 30,000 cub. ft. of air) that the iron melted should not be more or less than the 9.5 ratio stated.

The fact is that when the air and coke have been fixed in theoretical proportion, the iron charges may be determined by experiment and will be found to vary, according to the cupola characteristics, metal composition and section of castings, from 7.5 to as much as 14.0 ratio. The 9.5 ratio may be considered as the practical medium from which the economic optimum may be experimentally determined. Changes should be only gradual and each change should be given several days' trial before proceeding with any further alteration. In this way, there is little danger of such experiments causing any serious loss of castings.

Although there appears to be a popular tradition in the foundry that the coke charges should gradually decrease with the length of the heat, there is no logical reason for this, unless the air supply is under perfect control, and decreases accordingly. This is seldom, if ever, the case,

so that excessive oxidation occurs at the tail of the heat. Most of the scorification of the cupola lining occurs during this period, whilst the melting loss is also fairly high.

The oxidation of the iron is manifested by the emission of brown fumes from the cupola stack, the intensity of the colour being a measure of the extent of oxidation. Many metallurgists are inclined to blame the presence of dissolved oxide for some of the unexplained bad qualities of cast iron, although it should be stated in fairness that no positive evidence *pro* or *contra* this assumption exists. When a cupola has been warmed for some time before putting on the blast, as occurs in good practice, the cupola walls quickly attain a steady temperature condition, so that the theoretical ratio need not be exceeded much even in the beginning of the heat. The latter remark presupposes that the bed is solid when measured, as otherwise the bed will settle on charging, and the first metal will be rather dull.

The reason why it is usually assumed to be necessary to have the first few charges rather heavy is undoubtedly because of the tendency of the bed to settle on charging the cupola. Assuming the bed to be solid, the extra coke is consumed one way and another until the bed finds its own level, the melting being slow but hot during this period. If, however, the bed is somewhat hollow and no extra coke allowance is made in the first charges, the metal will be dull for a longer period. For this reason, it is sound practice to have, say, the first three or four charges, at a ratio of 1 in 7. The extra coke thus charged is really part of the bed.

Where diminishing coke charges are the rule, an analysis of the cupola practice will generally show the later coke charges to be too shallow to prevent contact of neighbouring iron charges. It will often be found that some of the coke charges are no deeper than 3 or 4 in., even allowing for level charging and descent of charges. Such small charges are manifestly bad practice, particularly when the charges are of a heterogenous character, for instance, Cleveland, hematite and steel scrap, and when regularity of composition during continuous pouring is required.

The average density of foundry coke may be fairly considered as 30 lbs. per cub. ft. at the melting zone level. In the usual foundry sizes it is rather less, but allowing for the breaking up due to handling and pressure of the charges, the density at the melting zone will approximate the above figure.

From the area of the cupola and the density of the fuel we may calculate the mean depth of any charge. Table I gives the factors for typical cupolas:—

TABLE I.

Size of Cupola in ins.	Area. Sq. in.	Coke required to give depth of 1 in.	8 in.
48	1,810	31.5 lbs.	252 lbs.
60	2,827	49 ,,	392 ,,
72	4,071	71 ,,	568 ,,
84	5,542	96 ,,	768 ,,

As an instance, it is quite common practice to use 4,000 lbs. iron charge for a 72-in. cupola with coke charges as low as 300 lbs. The mean depth of such a coke charge is only 4 in., which is obviously too shallow.

A little visualisation suggests that a charge of 8-in. depth should be the ideal, and it can be here stated that such charges have been found very successful in practice. Although it is not easy of explanation, it is found that fuel economies can be effected when the fuel charges are sufficiently deep. Table No. I gives the 8-in. coke charges for the various cupolas quoted.

Having thus decided on the coke charges and air supply, *i.e.*, 8-in. deep coke charges and 30,000 cub. ft. of air per 217 lbs. of coke, the only fluctuation that sound practice allows is in the weights of the iron charges. It may be found that the iron charges may be increased in weight at some part of the heat. The combustion factors, coke and air, should be left unaltered. Although this has been proved to be sound practice and is quite logical, it is seldom found in operation.

Portable Machines.

A New Electric Hand-Saw.

BY. J. M.

For many years after machine saws and planers were in general use in joiners' shops and other woodworking establishments many pattern shops carried on without a single machine. The writer recollects one fairly large pattern shop of a machine tool firm that had not even that most useful of woodworking machines, a bandsaw until a few years ago. Even to-day the value of machines is not always realised. There are few pattern shops in which, in addition to the usual band and circular saws, a swinging cross-cut saw would not be a labour saver in the timber shed. The swinging cross-cut saw cannot be called a portable saw, but there would appear to be scope in pattern shops, where large work is constructed, for electrically operated portable drilling machines, and it is rather surprising that the bench planing machine has never become popular. There is a great variety of work hand planed that could quite well be planed on a bench planer.

A new electric hand-saw has recently made its appearance that should ultimately become popular. In this machine one handle is of the type found on an ordinary hand-saw, the other the same as that used in guiding a hand plane. Both are close to the point of work, insuring accuracy and ease of operation. A splitter follows the saw blade, drops into the cut, and helps to guide the machine. An indicator in front makes it possible to follow a line, and the shoe is machined on one side to follow a guide rail. With the depth gauge which is provided, the saw can be set to cut accurately to any predetermined depth. A standard 8-in. blade is used. The saw is so designed that the motor cannot be overlooked by putting in a larger saw blade than the power unit is intended to handle. The guard is locked in a position which covers the blade at all points. When the operator wishes to cut, he simply releases the safety guard by means of a trigger conveniently placed near the grip. When the cut is finished and the saw is lifted from the work, the safety guard or shoe automatically drops and locks in position, covering the blade, and will not open again until released by the trigger. The blade is covered at all points above the point of work when the machine is in use.

Correspondence.

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

Special Cast Iron.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—As you are aware, for the last two years there has been a great deal of discussion and written matter in the technical Press and by the various technical institutes of this country relating to Perlit iron, and also to Thyssen-Emmel iron.

For some considerable time this company have been carrying on negotiations with Mr. Karl Emmel, the inventor of the Thyssen-Emmel process, and we are pleased to state this company has now acquired the patent rights in the Thyssen-Emmel process for Great Britain and the Dominions. In this country it is covered by patent No. 244,405 of 1924, and the company propose to exploit it in conjunction with the Perlit iron process, by selling an inclusive licence to their licensees, both present and future.

It is hoped as a result of this combination that the company will be in a position to enable all British engineering works and foundries to acquire a licence on the most reasonable terms for the manufacture of these admittedly superior qualities of grey cast iron, which are so much needed in relation to the production of high-class engines and machinery of all descriptions.—Yours, etc.,

THE BRITISH PERLIT IRON COMPANY, LIMITED.
JOHN A. SMEETON, Managing Director.
15, Victoria Street,
London, S.W.1.
August 19, 1927.

Electric Power in the Foundry—II.

By "Kilowatt."

Selecting Electric Motors.

While there are many factors that influence the selection of a motor and the kind of drive used in the foundry, the primary considerations are:—(1) Type of machine to be driven; (2) starting load; (3) speed requirements; and (4) local conditions.

The first three items are inter-connected, and knowledge of the machine to be driven decides the likely starting load and speed. The two factors in connection with any power drive are torque and speed, but to operate successfully, a motor must be of such a size and design that it will start and accelerate under normal conditions, and will carry a reasonable overload for a reasonable time. That it will carry its normal load, if necessary, under continuous running conditions, is practically assured if the makers state it to comply with British Engineering Standards Committee Specification. The chief risk lies in under-estimation of the load created by the machine or machinery that has to be driven, and, consequently, it often happens that a motor on the small side is chosen, which, when in operation, becomes overheated with consequent insulation and other troubles. This is, therefore, a factor to be guarded against, for considerable loss of efficiency results if much too large a motor is used, and run at only half load.

Motors for Cranes.

Dealing with the type of machine to be driven we will take first what is undoubtedly one of the most essential items in foundry equipment, the electric crane. In the first place there is the question of the system of electric supply available, A.C. or D.C., and while there are many cranes operating on alternating current if the choice of supply is available, opinion is distinctly in favour of the direct-current system, owing to its greater flexibility of control and higher operating efficiency. Of the three main type of direct current motors, series wound, shunt wound and compound wound, the series-wound machine is almost universally adopted, both on account of its high starting torque and its automatic speed variation.

The Series-wound D.C. Motor.

As the starting torque of cranes is high, a motor is called for that will exert a powerful torque at starting from rest, and this is really the outstanding characteristic of the series motor. Instead of varying directly with the current, as in the case of the shunt-wound motor, the torque increases practically with the square of the current, *i.e.*, if the current is doubled the torque will be increased nearly four times. Thus for the same current, the torque of the series motor will be much greater than that of the shunt-wound type.

This particular characteristic of the series motor is due to the fact that when a series-wound motor is switched on, the whole of the current flows through both field coils and armature, the effect in the field being to bring the magnetic strength to practically its full amount, thus the torque—taken as being the product of magnet strength and armature current—will be a maximum for that particular value of current.

Another feature which makes this type of motor suitable for crane work is its speed characteristic. The greater the load, the less the speed of the motor; on the other hand, as the load is lessened the motor speeds up, which is as it should be for rapid handling. If the load is taken completely off a series machine the armature will "run away," and for this reason braking is fitted to the hoisting unit to limit the downward speed.

The Slip-ring A.C. Motor.

Where the electrical supply is on the alternating current system the choice will lie with the slip-ring induction-type motor with a starting torque of at least 2.5, the full load torque. While it cannot be said that the speed characteristics of this machine is equal to those of the series motor, the slip-ring motor, by reason of the absence of a commutator, will withstand more severe conditions than the D.C. motor, and, generally speaking, the induction motor is simpler in construction. In order to obtain the high starting torque necessary, the slip-ring motor differs from its sister, the squirrel cage machine, by the provision of a more elaborate rotor winding, and the ends of the insulated coils are connected to slip rings placed outside the bearing on an extension of the shaft. The use of these slip rings is to provide a means of introducing resistance on starting into the rotor circuit and so increase its starting torque and reduces the starting current.

Squirrel Cage A.C. Motors.

Hitherto the squirrel-cage induction-type motor has been looked upon as quite unsuitable for crane work, owing to the excessive amount of current it takes when starting against a reasonable load. Moreover, it possessed a somewhat low power factor; acceleration was poor, and close inching difficult. These disadvantages, however, have now been overcome, after much experimental work on the part of manufacturers, with the result that there has been placed on the market several types of squirrel-cage motors designed to overcome these drawbacks and calculated to stand up to the slip-ring motor. In the first of these new machines, the manufacturers claim a starting efficiency from the point of view of torque and K.V.A. of approximately 75 per cent. than that of a standard motor with a power factor of the starting current correspondingly higher. In another design it is claimed to be capable of performing duties which have hitherto not been possible with squirrel-cage motors, and has been designed so that stopping and starting is carried out by means of a triple-pole switch, no other form of starter being necessary. It is capable of being started, stopped and reversed under full load from 600 to 1,000 times an hour with normal temperature rise, and has very smooth acceleration. A factor to be borne in mind in the choice of motors, whether A.C. or D.C., is the protection required for crane work, and to this end we find the totally-enclosed machine usually adopted in foundry work.

To determine the horsepower of the motor required to drive hoisting mechanism a convenient rule is

$$\text{H.P.} = \frac{\text{foot tons per minute,}}{10}$$

whilst to calculate the power required to travel a crane, attractive force of about 60 lbs. per ton is usually taken for cranes operating in sheltered positions. For outdoor work the effect of wind pressure must be taken into consideration.

Control Equipment for Cranes.

As in the case of all other electrically-operated machinery in the foundry, the efficient operation of the crane depends on the control gear, and very careful attention must therefore be paid to this section of the equipment. The duties it has to perform are severe, and only the most robust apparatus will give satisfactory service.

The most usual type in use is the "drum"-type controller. The resistances are usually of grid construction, but in some of the small units a wire-wound resistance is more suitable. There should be ample room inside the controller for connections, all parts should be accessible, finger tips and drum contacts easily renewable, mica insulation, and a definite step should be felt as the barrel is moved round to each contact. With direct-current controllers a magnetic blow-out should be fitted.

For use with drum controllers, auxiliary apparatus, such as resistances, brake solenoids, limit switches, etc., are usually employed, and as drum controllers in themselves give no protection against overloads or other risks that may be incurred, the installation of additional protective apparatus is essential.

Solenoid brakes have a wide field of application on cranes and hoists, for use with automatic brakes fitted with electro-magnetic release, the brakes being mechanically applied and constantly in action, except when lifted by the solenoid when current is applied to the motor.

For alternating current, shunt solenoids are supplied, and for direct-current circuits either series- or shunt-wound solenoids are available. In general, except for small motors, series solenoids

should be used where possible, as, having fewer turns of heavier wire, they tend to be more robust than the shunt solenoid, besides avoiding the slightly sluggish action caused by the induction of the latter. Shunt solenoids, however, must be used under certain conditions, such as for small motors where rheostatic braking is employed, and under conditions of variable load where the load is liable to fall to a point where the current is reduced to a low value that is insufficient to hold up the brake.

With the idea of preventing accidents occasioned by momentary thoughtlessness and carelessness on the part of the driver, several protective arrangements are available and the application of a limit switch can be adopted for overwinding or overtravel. The last named can be applied to both directions of travel of the crane on the gantry rails or to the crab on the crane girders. An overwinding limit switch of the self-resetting type cuts out the hoisting side only, thus allowing the operator to lower the load after an overhoist, and on lowering the load to a safe level the switch automatically resets.

The principle of operation is identical in all cases, a mechanical trip gear which causes the current to be cut off from the motors. When lowering a load, great care has to be taken that it is not left free to run down at ever-increasing speed, but is let down gently with a firm, reliable braking action. The trouble with mechanical braking devices is that the co-efficient of friction varies, and also that wear and tear takes place necessitating frequent adjustment. To avoid these defects, the system of dynamic braking was designed, and in this system, when the load is lowered, the motor circuit is disconnected from the supply lines, and then connected through an adjustable resistance to form a complete circuit in itself.

The power of the falling load is applied to the motor, which acts as a generator-driving current through the series-field winding and adustable resistance. The less the resistance in circuit, the greater the current generated, and the greater the braking effect on the load.

An arrangement is made in the controlling gear on this system of dynamic braking for reversing the armature connections in order to cause the generated current to pass through the field coils in the same direction as the current supplied from the line. If this were not done, and the current passed in the reverse direction, the field would become demagnetised, and the braking effect would be nil. A main automatic circuit breaker and relay switches for each branch circuit is preferable to a main switch and fuses, as this often saves much valuable time at critical moments.

Keeping Metal Hot.

By J. Ellis.

There are, of course, many foundries not equipped with receivers to their cupolas, nor are they blessed with a large number of ladles of various sizes, and sometimes a job comes along requiring more metal than the receiver or ladles will hold. In such cases generally a sow is built up near the runner of the mould and the metal carried to it and poured in according to the melting capacity of the cupola. Usually a moulding box of the required size is placed upon a strong loam plate, this is then lined with bricks and a daubing of loam, blacked and thoroughly dried. At a convenient place a hole is made through the bottom to allow the metal to pitch into the runner basin of the mould; this hole is sealed while the metal is being collected in the sow. A plug is used to seal this hole, this plug must be made very strong, usually a strong core barrel is used and struck up as an ordinary straight core would be struck, but no straw rope should be used, as this would very soon get burnt. Then at the time of drawing the plug, the barrel is liable to come away, leaving the coating of loam in the metal. The better way is to drive small pieces of wrough iron into the vent holes of the barrel, letting the ends stand out according to the thickness of loam to be put on. This method when adopted will build up quite a sound and strong plug.

The greatest care must be exercised to keep the metal hot while it is being gathered in the sow. This can only be achieved by a cover of some sort, the best is sawdust and blacking in equal parts, which is the custom when collecting large quantities of metal in ladles or sow. It is very rare that a receiver is large enough to hold enough metal to give the desired amount for a certain job in one tap, therefore cover *must* be used to keep hot the metal in the ladle whilst the cupola is melting the desired quantity. There is not the slightest danger of doing harm to metal by covering it with blacking. Very many large castings, and small, too, for that matter, have been made, and are being made, the metal of which have had a blacking-sawdust cover, and it would be difficult to find better castings anywhere. Long experience teaches that it is very sound and good practice to cover metal while it is being collected. This cover can and is readily and easily removed by skimming; in fact, it is far easier to remove the dross from the metal in the ladle, which has had a covering of blacking than without. It would be a very serious thing to attempt to collect large quantities of metal in a ladle or sow without cover of some sort; the metal would decrease in temperature perhaps to such an extent as to render it unfit to pour a mould with, even if it would run out of the ladle, it might not fill the mould in the proper manner.

A Concrete Case.

In a large foundry in Yorkshire a job was taken, the weight of which was ten tons, and therefore twelve tons of metal was required to pour the mould. One 10-ton and one 3-ton ladle were used, and five taps of two tons each were required to fill the larger ladle, occupying quite two hours, and as the job was very thick in section it was thought to be unnecessary to use cover. When this ladle was full it was lifted from the cupola front and allowed to stand whilst the smaller ladle was being filled. This was taken up to the mould first by the light travelling crane, then the 10-ton ladle was taken up to the job by a more powerful crane. When all was ready to commence pouring the 10-ton ladle was tilted but no metal came out, because the top of the metal had actually solidified. Amid great excitement powerful crowbars were brought into use to break a hole through the crust, and it was some time before this could be done. Even so only a hole about 2½ in. dia. was made, then pouring commenced. Fortunately as the hotter metal passed through this hole it became larger, and so the mould was cast. Had not the 3-ton ladle been used as a standby the casting would have been a waster. The ladle had to be completely knocked out and the frozen top taken to be broken up under the drop ball. All this trouble and worry could have been avoided had some sort of cover been used. It is invariably wise to play for safety by keeping the metal as hot as possible as there is not much difficulty in getting it to cool down.

Shipping, Engineering and Machinery Exhibition.

This Exhibition will be opened at 12.45 p.m. on Thursday, September 8, by the President, His Grace the Duke of Northumberland, K.G., C.B.E., M.V.O. His Grace will arrive at the main entrance to the building at 12.15 p.m., and will make a brief inspection of the exhibits before declaring the exhibition open. The ceremony will be followed by a private informal luncheon, the official commemoration function taking the form this year of a banquet at 7 p.m., in place of the usual opening luncheon. This banquet is also given partly in honour of overseas visitors, of whom a large number are expected to be present.

On Monday, September 12, there is to be an official visit by the Institution of British Foundrymen and the British Cast Iron Research Association.

Not from "Punch."

According to a provincial daily, a serious accident in the Hofherr Schratz foundries at Innsbruck was caused by perspiration from one of the workmen falling on to liquid iron in a mould.

An explosion occurred, the mould was broken, and the liquid iron spilled over the workman, who was taken to hospital in a serious condition.

Foundry Purchasing—XI.

By Eric N. Simons.

Buying is a vast subject, and hard-and-fast rules cannot be laid down for the organisation of any and every foundry buying office. For example, some firms would find it impossible to organise their buying department on these lines because the extent of their activities is so great that it would be impracticable to make one assistant responsible for the detail work of even one class of purchases. They find it more economical to have separate assistants, each entrusted with one function alone and no other, the buyer and his chief assistant being the *foci* upon which these functions converge. Thus, one assistant concentrates on the preparation of statistics, and is given full freedom to obtain information regarding prices, sources of supply, previous transactions, price-lists, test-sheets and inspectors' reports, etc., so that he may keep every record required in current form.

Under this scheme there would be another assistant doing nothing else but requisition work, *i.e.*, seeing that adequate details are given on requisitions, that the department to which the goods are to be charged or allocated in the account-ledgers is indicated clearly, that the slip is signed by a competent authority, and so forth. A third assistant would be in sole charge of prices. His task would be to indicate on orders the prices at which they were placed, obtaining these details from an examination of contracts or agreements actually existing, or by getting in firm quotations from suppliers. Of course, his work would be supervised by the purchasing agent himself. Next, in a buying department so organised, there would be an order clerk, who would make out orders, embodying in them the various clauses relative to tests, specifications, delivery requirements and times, etc., but omitting prices, which would be filled in by the price clerk. He would present them to the buyer for sanction and signature, and make himself responsible for their despatch to the correct addresses.

It is sufficient to add that there would, in the same way, be separate assistants for following up and obtaining delivery of orders; for receiving and inspecting goods on or before arrival; for attending to invoices; for arranging storage; and so forth. The difference between this system of organisation and that previously recommended by the writer is not so much one of kind as of degree. The amount of work to be done is really the governing factor. When the department is extraordinarily large and active, it becomes essential for each member to specialise, whereas in the more frequent and smaller departments it is possible for each man to control a certain number of different though connected sections of the work. It need scarcely be said that wherever the circumstances of the department allow the unspecialised —or, to speak more accurately, the unsectionalised —grouping of assistants is better than the sectionalised, for reasons already indicated. In theory, the concentration of each assistant on one section of the work alone has great advantages; but in practice it tends to throw too much personal responsibility on the buyer and his chief assistant, who have to weld together into a harmonious whole this collection of specialist assistants; it tends, also, to hinder co-operation among the buying department staff; to make each man lose touch with the realities of the department's position; and to inculcate a narrow and unimaginative attitude on the part of assistants.

Duties of the Storekeeper.

The storekeeper's interest in the work of the department begins on the day that the goods are advised, if one excludes his first notification to the buyer that stocks of certain commodities need to be replenished. He should receive all advice notes of incoming (*i.e.*, ordered) supplies. The parenthetical elaboration of this phrase is essential, because in some firms certain packages containing goods not ordered but supplied by customers to help in the execution of their orders are delivered, but do not go to the storekeeper at all. (As an example, one may mention foundry patterns, which have nothing whatever to do with the general stores or the buying department, being supplied free of charge by the purchasers of castings. There may be a separate pattern store, but its methods and arrangement may be entirely different from those of the general stores.) In certain instances the storekeeper functions quite independently of the buyer and his department, having his own staff, and being, to some extent, the head of a separate department. This is particularly true of certain very big foundries. But in the main, British practice is to subordinate the storekeeper to the buyer, and to make the stores a branch of the buying department, subject to its authority, and acting in accordance with its instructions.

A stores department has to be responsible for the following, irrespective of its dependence or independence, its size, or the number of its staff:—

(*a*) Taking in all deliveries of ordered goods; (*b*) inspecting, counting, weighing and measuring; (*c*) making sure that the deliveries correspond with stores requisitions; (*d*) checking over with advice notes to see that no loss or damage has been sustained in transit; (*e*) sending promptly to the proper persons goods required for immediate use; (*f*) putting away in suitable lockers, bins, compartments, etc., goods to be retained in stock; (*g*) noting down particulars of goods received, goods sent immediately to the right quarter, and goods passed into stock; (*h*) inquiring into the right destination for any goods not actually advised, whose destination or purpose is not known, and delivering to destination when discovered, if not for stock; (*i*) notifying the buying department immediately of any goods for which no destination can be found, with details; (*j*) supplying goods to producing and other departments against correctly signed requisitions; (*k*) keeping proper records of all such materials supplied; (*l*) keeping a close watch on maximum and minimum stocks, advising the buyer immediately there is danger of the limits in either direction being exceeded; (*m*) receiving saleable scrap or waste into the stores, classifying, weighing, measuring and sorting it, and notifying the buyer of the amounts available for sale; and (*n*) issuing of this scrap to purchasers on receipt of signed instructions from the buyer.

This covers most of the stores functions. It is evident that in charge must be placed a man of great integrity, with some knowledge of figures, and with the ability to issue instructions clearly. He should have at least one clerk to assist him in keeping the essential records, and, of course, he will have a staff of manual workers to do the lifting and carrying indispensable. Sometimes it may be necessary for him to draw upon unskilled labour in the producing departments whenever his own staff is unable to cope with the work in hand. He must have authority to approach foremen or managers of production departments for this purpose, and the latter must be instructed to grant him the assistance he needs unless circumstances render it wholly impossible. The general feeling among departmental managers towards the buyer will largely affect the manner in which they receive requests of this sort from the storekeeper. If he is unpopular they will throw obstacles in the storekeeper's way. If popular they will do all they can to help him by providing the necessary labour. This is but one of the many instances in which pleasing personality in both buyer and storekeeper will remove obstacles to efficiency. The storekeeper himself should be of tactful and cheerful disposition, since he will—perhaps even more than the buyer—have to come in contact with the individual departments.

One point the storekeeper will have to watch very carefully is pilfering. There are few foundries in which something of this sort is not attempted; not always by employees of the foundry itself, but often by carters coming into the works from supplying firms, and so forth. It is the frequency with which he checks over his stock-records with the stock itself that will enable him most readily to detect theft, and the more quickly he discovers it the more quickly can he take measures to catch the thief or prevent further losses from this source.

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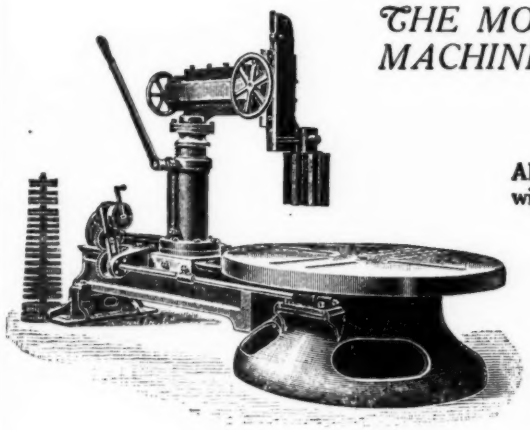

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Commercially Pure Iron Alloyed with Molybdenum and Copper.

BY C. H. W. TUPHOLME.

A great future is predicted for a new commercially pure iron, containing not more than 0.25 per cent. impurities, *i.e.*, 99.75 per cent. pure iron, alloyed with 0.40 per cent. copper and 0.07 per cent. molybdenum. This material is being adopted for a wide range of purposes on account of its resistance to corrosion, especially in the form of corrugated sheets for constructional purposes where the buildings are exposed to corrosive influences such as are found in and around collieries, coke-oven plants, and chemical works.

In Fig. 1 the new alloy is shown compared with pure iron without alloys. Samples of both were submerged in a 10 per cent. hydrochloric acid solution, and at the end of five weeks the copper-molybdenum iron had lost 2.8 per cent. of its weight, while the pure iron had lost 48.4 per cent. In Fig. 2 the copper-molybdenum iron was compared with copper bearing steel, both being submerged in 10 per cent. hydrochloric acid solution. After four weeks the iron had lost 1.9 per cent. and the steel 52.7 per cent.

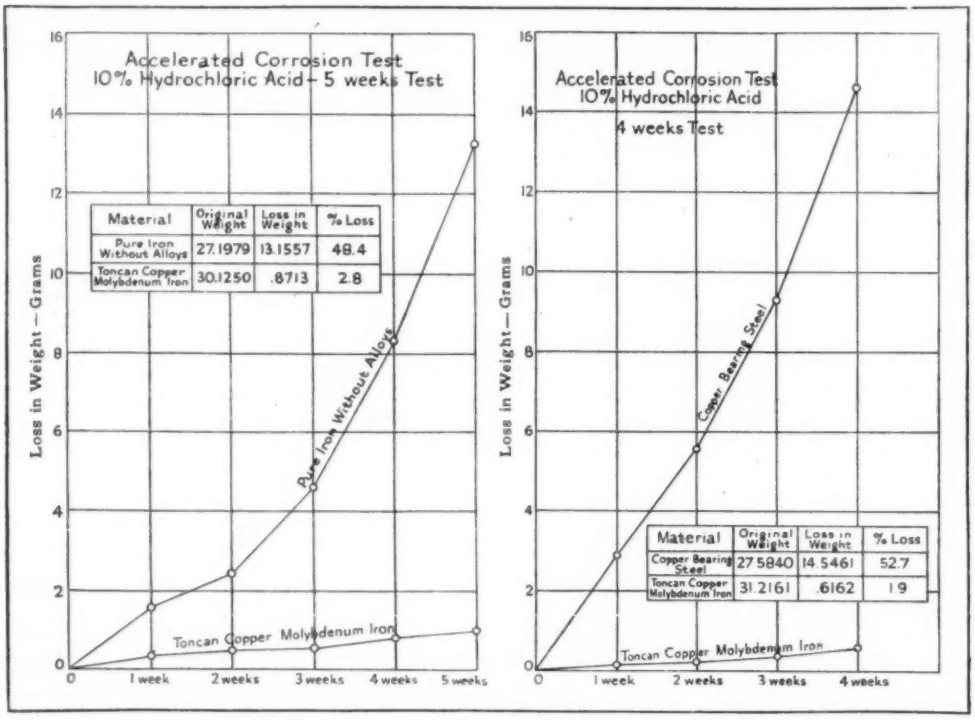
Accelerated Corrosion Test
10% Hydrochloric Acid – 5 weeks Test
Material | Original Weight | Loss in Weight | % Loss
Pure Iron Without Alloys | 27.1979 | 13.1557 | 48.4
Toncan Copper Molybdenum Iron | 30.1250 | .8713 | 2.8
Loss in Weight – Grams
Pure Iron Without Alloys
Toncan Copper Molybdenum Iron
0 1 week 2 weeks 3 weeks 4 weeks 5 weeks
Accelerated Corrosion Test
10% Hydrochloric Acid
4 weeks Test
Material | Original Weight | Loss in Weight | % Loss
Copper Bearing Steel | 27.5840 | 14.5461 | 52.7
Toncan Copper Molybdenum Iron | 31.2161 | .6162 | 1.9
Loss in Weight – Grams
Copper Bearing Steel
Toncan Copper Molybdenum Iron
0 1 week 2 weeks 3 weeks 4 weeks

FIG. 1. FIG. 2.

The following table shows a comparison of the three metals as regards their physical properties:—

	Cu. Mo. Iron.	Pure Iron.	Cu. Steel.
M.S., tons per sq. in. ...	29.7	20.0	25.9
Y.P., tons per sq. in. ...	17.3	10.5	20.9
E., per cent. (4 ins.) ...	33.75	27.5	21.25
R.A., per cent.	46.30	37.40	33.40

Catalogues Received.

Thermostatic Regulator.—Messrs. Hopkinsons, Limited, of Huddersfield, in their list No. 2030, describe in full detail Type R Patent Thermostat. The apparatus is definitely an engineering job, which is more than can be said for some which have passed through our hands.

Air and Gas Filtration.—The Wellman Bibby Company, Limited, of Victoria Station House, London, S.W.1, have prepared a 16-page, well-illustrated brochure which describes a system of air or gas purification based on the passage of dust-laden gas through a series of trays containing quantities of oil-coated shingle. For renewal, the shingle is merely washed in hot water, re-coated with oil, and the tray replaced. The shingle referred to consists of a number of metal spirals.

Iron and Steel Institute.

Annual Meeting at Glasgow.

Supplementing the information given in our issue of June 30 last, the following is a list of the works to be visited during the meeting:—

Tuesday, September 20.—(1) David Colville & Sons, Limited, Clydebridge Works. (Melting shop, cogging mill, electrically-driven three-high plate mill, shearing plant with Ennis mechanical tables, etc.) (2) Fredk. Braby & Company, Limited, Eclipse Works. (Sheet mills, galvanising, etc.) (3) Steel Company of Scotland, Limited, Blochairn Works. (Melting shop, universal cogging mill, heavy plate mills, tyre mills, etc.) (4) Babcock & Wilcox, Limited, Renfrew. (Water-tube boilers, chain-grate stokers, electric cranes, etc.)

Wednesday, September 21.—(1) Wm. Beardmore & Company, Limited, Mossend Works. (Melting shop, section mills, three-high plate mill, etc.) (2) Stewarts & Lloyds, Limited, Clydesdale Works. (Melting shop, mechanical gas producers, electrically-driven universal plate mill, etc.) (3) Glasgow Iron & Steel Company, Limited, Wishaw Works. (Blast furnaces, by-product recovery plant, and cement plant.) (4) Smith & McLean, Limited, Garteosh Works. (Sheet mills, etc., electrically-driven throughout.) (5) Mavor & Coulson, Limited, Mile End, Glasgow. (Coal-cutting machinery, underground conveyors, etc.)

Thursday, September 22.—(1) Scottish Iron & Steel Company, Limited, Waverley Works. (Malleable iron works, steel works, electrically-driven reversing section mill, waste-heat recovery, etc.) (2) Wm. Bain & Company, Limited, Whifflet Works. (Wire-drawing, barbed wire and strand wire for fencing, etc.) (3) Scottish Tube Company, Limited, Coatbridge Works. (Lap- and butt-welded tubes, fittings, etc.) (4) R. B. Tennent, Limited, Coatbridge Works. (Steel and iron foundry, steel grain and chilled rolls, etc.)

As already announced, the invitations of the various Companies to visit their works are limited to 50 visitors, and it is not possible to include ladies in the invitation.

Analysis of Wabana Ores.—A German paper publishes the following analysis of Wabana iron ores from Bell Island, Newfoundland:—Fe, 48 to 57 per cent.; Si, 6 to 12 per cent.; P, 0.70 to 0.85 per cent.; S, 0.018; specific gravity, 3.95 to 4.12. The ore is a compact fine-grained oolite.

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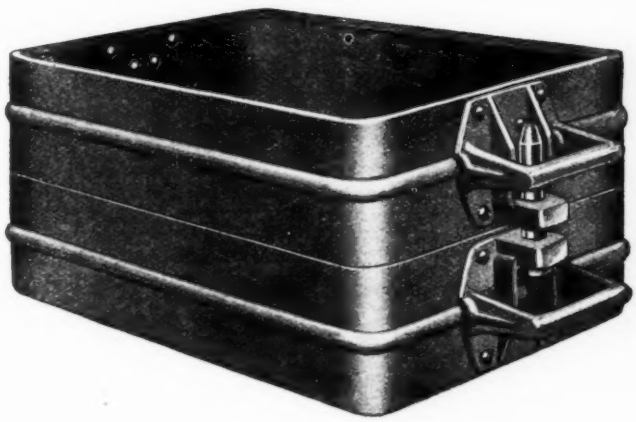

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Trade Talk.

Mr. Willy Heineman, iron and steel merchant, of 60, Rue Saint Lazare, Paris, has recently opened London offices, as Heineman & Company, at 115-117, Cannon Street, E.C.4, under the management of his partner, Mr. R. W. Reeve.

Mr. G. W. L. Simmons and Mr. A. V. Reynolds, formerly associated with Stedman, Crowther & Company, metal merchants, have established themselves in business at 82-84, Fenchurch Street, London, E.C.3, trading as Simmons, Reynolds & Company, metal merchants.

The Spalding Urban District Council has placed an order with the Woodall-Duckham Vertical Retort and Oven Construction Company (1920), Limited, for a further installation of Woodall-Duckham continuous vertical retorts. The new installation will comprise six unit retorts. It will be arranged in an existing horizontal-retort house. The installation includes the necessary coal- and coke-handling plant, and is arranged so that a waste-heat boiler can be added at a later date. The Newmarket Gas Company also has placed an order with the Company for an installation of Woodall-Duckham continuous vertical retorts, comprising six retorts.

Messrs. Siemens and English Electric Lamp Company, Limited, Caxton House, Westminster, London, S.W.1, inform us that they have passed a resolution changing the name of the Company to Siemens Electric Lamps and Supplies, Limited, and the necessary consent of the Board of Trade has been obtained. The registered office will be at Caxton House, Westminster, as heretofore. All contracts entered into and obligations incurred by Siemens and English Electric Lamp Company, Limited, will be carried out and discharged by Siemens Electric Lamps and Supplies, Limited, who will also retain all the rights and privileges of Siemens and English Electric Lamp Company, Limited.

The statistical summary of ships totally lost, broken up, condemned, etc., published by Lloyd's Register, shows that during 1926 the gross reduction in the mercantile marine of the world amounted to 838 ships of 1,343,943 tons, excluding all ships of less than 100 tons. Of this total, 656 ships of 1,226,873 tons were steamers and motorships, and 182 of 117,070 tons were sailing ships. These figures, compared with those for 1925, show an increase of 246,079 tons as regards steamers and motorships, and a decrease of 44,171 tons for sailing ships—the net increase for 1926 being 201,908 tons. This is not altogether due to actual casualties—the figures for which show an increase of 100,492 tons for steamers and motorships—but also to the fact that 851,232 tons were broken up during 1926, as against 746,560 tons in 1925. The tonnage of ships, owned in Great Britain and Ireland, which were broken up, dismantled, etc., during 1926 amounts to 153,318 tons.

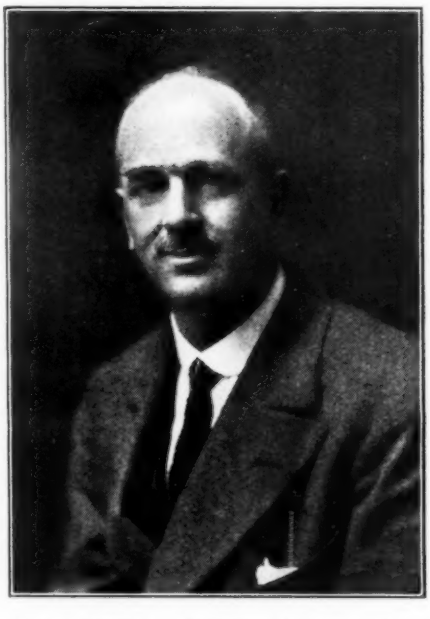
Mr. Lewis Jones, secretary of the South Wales Siemens Steel Association, in an address on "The Economics of the Iron and Steel Trades," given to the Glamorgan Summer School at Swansea last Friday, said that steelmakers were really anxious to make serious attempts to reduce their prices with a view to defeating foreign competition, but there were many reasons why that was not altogether possible—the most important at the moment being the fact that they could not see any hope of sufficient business to work their plants at anything approaching normal outputs. In fact, the most rosy estimates at the moment gave a possible output of about 70 per cent. even were the whole of the bars consumed produced in South Wales. Tinplate makers who used the dear Welsh bar had to sell their plates at prices dictated by the low-priced foreign bar. If the so-called Welsh tinplates were manufactured from Welsh bars and not from foreign bars it would mean still further work for a large number of men within a radius of twenty miles of Swansea.

British Industries Fair, 1928.—The management of the Heavy Section of the British Industries Fair report that the space definitely booked for the 1928 display in Birmingham is some 5,400 sq. ft. in excess of the total space occupied by the entire Exhibition in that city last February. This constitutes a new record in the history of the Fair, and is the more remarkable in view of the great extensions, totalling 120,000 sq. ft., at a cost of £30,000, which were carried out for the 1927 Fair when, notwithstanding this increase of area, every available foot was occupied. The Fair authorities note with legitimate satisfaction that 93 per cent. of the exhibitors of last February have re-booked their positions, and that 178 firms have applied for larger space, chiefly for the purpose of additional working exhibits.

Personal.

Mr. Victor A. Dixon has been appointed a director of Turton Brothers & Matthews, Limited, Sheffield, makers of steel, files and springs.

Mr. Walter C. Macartney, who recently took up the appointment of managing director of the well-known engineering firm of Markham & Company (1925), Limited, Broad Oaks Works, Chesterfield, served his apprenticeship in the Steelworks Department of Sir W. G. Armstrong Whitworth, and



Mr. Walter C. Macartney, Managing Director of Messrs. Markham & Company (1925), Limited.

was appointed an under manager in the Ordnance Department, being in charge of the manufacture and erection of gun mountings and electrical gear on warships, serving in all some fifteen years with this Company. He was two years in South Africa with the Northumberland Artillery Brigade during the South African War, afterwards accepting an appointment with Messrs. John Brown & Company, Limited, as assistant to the directors. Mr. Macartney also was for twelve years works manager with the Coventry Ordnance Works, a subsidiary of Messrs. John Brown and Cammell Laird, and for five years was managing director of Walter Somers, Halesowen.

Wills.

Greenway, Mr. Henry Havelock, of Hagley Road, Edgbaston, Birmingham, ironmaster £49,796

Anderson, Mr. Alexander Robertson, of Lainshaw, Kilmarnock Road, Giffnock, sometime iron and steel merchant ... £11,287

Spencer, Arnold McTurk, of Whiteley, Wood Grange Ranmoor, Sheffield, joint managing director of Walter Spencer & Company, steel file and tool manufacturers, Sheffield £12,047

Hutton, J. J., of The Newlands, Ridgeway, Eckington, Derbyshire, proprietor of The Phœnix Sickle and Scythe Works, and a director of Thomas Staniforth & Company, Limited £12,833

New Companies.

The Fife Non-Ferrous Company, Limited, 125, Buchanan Street, Glasgow, C.2.—Capital £5,000 in £1 shares. Extractors of metals, refiners, and smelters.

Caird & Rayner, Limited, 777, Commercial Road, E.14.—Capital £21,000 in 20,000 cumulative participating preference and 1,000 ordinary shares of £1 each. Engineers.

Kleenglas, Limited, 34, Clements Lane, E.C.4.—Capital £1,575 in 1,500 5 per cent. cum. pref. shares of £1 and 1,500 ord. shares of 1s. Engineers. Directors: P. C. Vesty, J. D. Massett, A. Griffiths, and S. R. Tompsett.

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a fine dry powder, packed in a drum—air and watertight. Please ask for booklet.

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IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—The decision last week of the Cleveland ironmasters to reduce the prices of their products was as unexpected as it was welcome to the trade, the readjustment of quotations amounting to 2s. 6d. per ton all round, while for orders of not less than 500 tons from Scotland and abroad concessions of 5s. per ton are to be allowed. Thus there is established a differentiation of 2s. 6d. per ton as between home and export prices, Scotland being accorded the benefit of the latter. It is obviously a bid to recapture foreign markets, and the local ironmasters are not without hopes of success. This development, if somewhat belated, should certainly check the flow of foreign imports, and, if it also gives a fillip to the export trade, it will only be a fitting return for the heavy sacrifices which the ironmasters have made. The new scale of prices is as follows:—Home, No. 1 Cleveland foundry, 70s. per ton; No. 3 G.M.B., 67s. 6d.; No. 4 foundry, 66s. 6d.; No. 4 forge, 66s. For export and Scotland, prices on 500-ton lots are: No. 1 foundry, 67s. 6d.; No. 3, 65s.; No. 4, 64s.; and No. 4 forge, 63s. 6d.

The market for hematite iron is still very restricted, but so, too, is the output, and without increasing their stocks East Coast producers have been able to keep prices unchanged at 75s. 6d. per ton for mixed numbers and 76s. for No. 1 quality. On the North-West Coast prices are unchanged. Bessemer mixed numbers being quoted at 75s. per ton at works, while low-phosphorus iron is 5s. per ton above that figure. There is a fair demand for malleable iron at 101s. per ton.

LANCASHIRE.—The reduction in Cleveland iron prices, announced above, has so far had little effect upon local markets, and in this area Staffordshire makers have been quoting about 75s., Derbyshire from 75s. 6d. to 76s., and Scottish from 93s., with hematites on offer at 89s. to 90s. These rates are fairly steady for small prompt parcels, but for a good order they would probably be shaded a little.

THE MIDLANDS.—In the local markets for foundry pig buying is almost entirely restricted to consumers' immediate requirements, and price changes are few and unimportant. Quotations rule about as under:—Northamptonshire, 61s.; Derbyshire No. 3, 66s. to 67s. 6d.; with Staffordshire quality also 66s. to 67s. 6d.

SCOTLAND.—As far as Scotch iron is concerned, there is no improvement to report. No. 3 Scotch foundry can be bought at 75s. 6d. f.o.t. furnaces, but even at this low figure, at which makers say they are losing money, consumers are not to be tempted to make contracts, and continue to buy only the smallest quantities.

Finished Iron.

Conditions in most of the manufacturing branches of the industry continue unsatisfactory, and in South Staffordshire makers cannot get sufficient orders to carry on their mills continuously. Orders coming through lack bulk, and there is a large amount of price-cutting. From works outside the district £9 15s. is being quoted for crown quality, and this may be taken as being the cheapest figure, with an average of about £10. Second-grade iron is between £9 and £9 5s. There has been no alteration in the price of Continental nut and bolt iron, which is quoted at £5 17s. 6d. to £6, delivered locally. Staffordshire marked bars remain at £13 10s. at makers' works.

Steel.

Sheffield reports a lack of business in the steel market at the moment, but there are some indications of impending improvement. Better inquiries for acid billets are reported, but basic billet producers are up against sharp Continental competition. Siemens acid billets continue at £10 per ton delivered, and basic billet prices are:—Soft, £7; medium, £7 12s. 6d.; hard, £8 2s. 6d. and £8 12s. 6d., all per ton delivered. The production of open-hearth steel has not been further restricted, and makers of special steels are doing fairly well. The tinplate market continues in an unsatisfactory condition. The demand is weak and shows little signs of expanding. Prices have developed a steadier tone. Prices for I.C., 20 x 14 plates, vary between 18s. 4½d. and 18s. 6d. per box, f.o.b.

Scrap.

Reports from the various centres of the scrap metal trade continue disappointing, very little business being in evidence anywhere, and the outlook far from promising any early revival of activity. As concerns buying on foundry account, the prospect is far from encouraging, and in Scotland it is difficult to find outlets, particularly for heavy machinery metal in pieces not exceeding 1 cwt., which is being disposed of in small lots around 70s. per ton, and for heavy ordinary cast-iron scrap to the same specification, 4s. to 5s. per ton less. Cast-iron scrap suitable for steelworks and in furnace sizes is also around 65s. per ton. There is no change in light cast-iron scrap around 57s. 6d. to 60s. per ton. The above prices are all per ton, delivered, f.o.t. consumers' works.

Metals.

Copper.—The market for warrant copper, following recent heavy purchases, has developed a weaker tendency in values, in which there has been a substantial shrinkage during the past week or so. The feeling, however, is gaining ground that consumers are not too well covered for forward, as of late the purchasing of supplies has been restricted mainly to current requirements.

Official closing prices of standard copper have been as follow:—

Cash: Thursday, £55 1s. 3d. to £55 3s. 9d.; Friday, £55 3s. 9d. to £55 6s. 3d.; Monday, £55 3s. 9d. to £55 5s.; Tuesday, £55 to £55 2s. 6d.; Wednesday, £54 15s. to £54 17s. 6d.

Three Months: Thursday, £55 8s. 9d. to £55 11s. 3d.; Friday, £55 11s. 3d. to £55 12s. 6d.; Monday, £55 11s. 3d. to £56 12s. 6d.; Tuesday, £55 7s. 6d. to £55 8s. 9d.; Wednesday, £55 3s. 9d. to £55 5s.

Tin.—Although fluctuations in standard tin values of late have covered a fairly extensive range, the market, on the whole, has continued steady, closing at the week-end firmer than had been expected. On the American market activity has varied somewhat, but later advices report that it is more favourably inclined, with prices tending, if anything, to be slightly firmer.

Official closing prices of standard tin have been as under:—

Cash: Thursday, £291 5s. to £291 10s.; Friday, £291 15s. to £291 17s. 6d.; Monday, £289 10s. to £289 12s. 6d.; Tuesday, £289 2s. 6d. to 289 5s.; Wednesday, £292 to £292 5s.

Three Months: Thursday, £284 17s. 6d. to £285; Friday, £285 12s. 6d. to £285 15s.; Monday, £284 10s. to £284 15s.; Tuesday, £284 2s. 6d. to £284 5s.; Wednesday, £286 10s. to £286 15s.

Spelter.—Weaker quotations have been the prevailing feature in this section of the market recently, the position having been adversely affected by the fact that Germany is reported to be the holder of an excess of supplies. Galvanisers are said to be more busily employed, and an improvement in their demand is looked for.

The following are the week's prices:—

Ordinary: Thursday, £28; Friday, £28; Monday, £27 17s. 6d.; Tuesday, £27 15s.; Wednesday, £27 18s. 9d.

Lead.—In the market for soft foreign pig, the improvement recently noted has apparently fallen away again, and the fact that certain trades, which in the usual way are heavy users of lead, are at the present time not fully employed, has no doubt substantially decreased the quantity of metal that would have been used in more normal conditions.

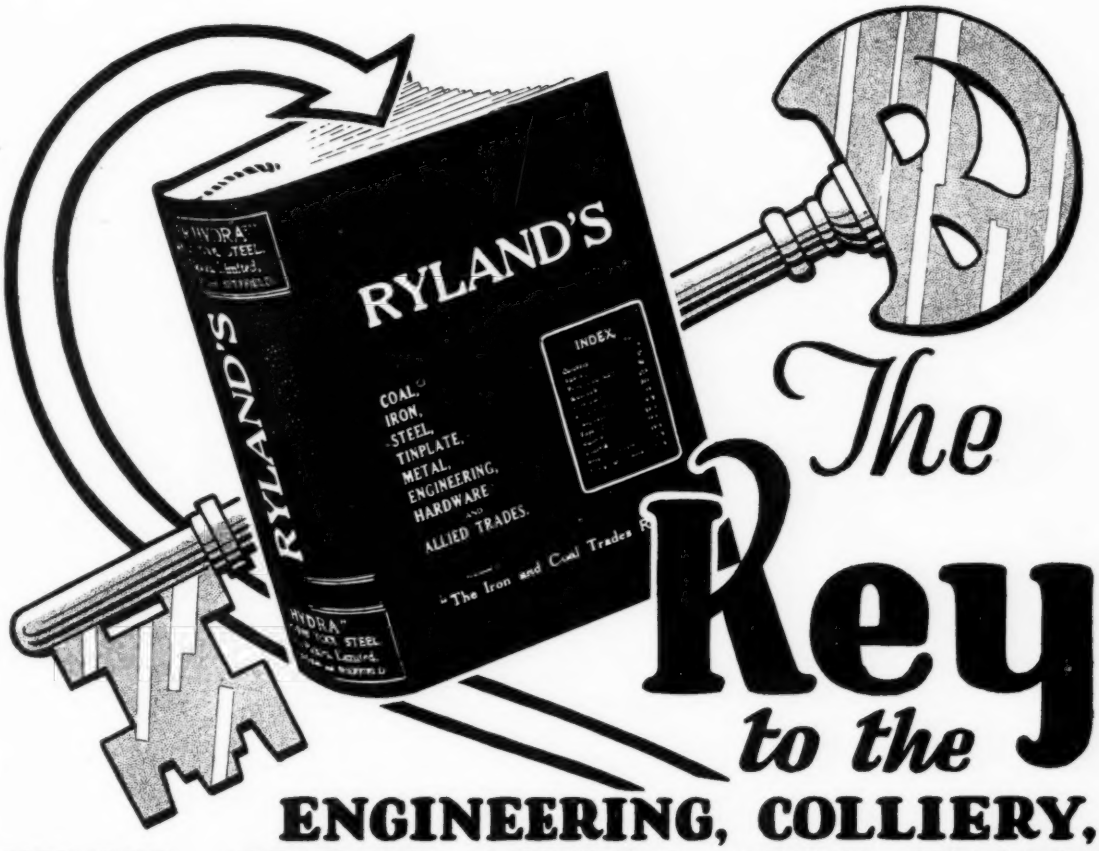
The week's prices are appended:—

Soft foreign (prompt): Thursday, £22 18s. 9d.; Friday, £22 15s.; Monday, £22 15s.; Tuesday, £22 15s.; Wednesday, £22 15s.

Iron and Steel Production.

The National Federation of Iron and Steel Manufacturers, in their Statistical Bulletin for June, state that it was clear from the May figures that the peak of production caused by the accumulation owing to the coal stoppage had been passed and the figures for June show a further substantial decline. The number of furnaces in operation which had fallen from 189 to 184 during May, further fell during June to 176, while production of pig-iron declined from 720,100 tons in May to 651,300 in June. The production of steel ingots and castings, which amounted to 884,600 tons in May, fell to 747,300 tons in June.

The output of pig-iron during the first six months of the current year was 3,728,900 tons, as compared with 2,273,700 in the first half of 1926, and that of steel 4,989,100 tons in the first half of the current year, compared with 2,869,500 tons in the first half of 1926.



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WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	54	15	0
Three months	55	3	9
Electrolytic	61	15	0
Tough	59	5	0
Best selected	60	5	0
Sheets	86	0	0
India	72	0	0
Wire bars	62	10	0
Do. September	62	5	0
Do. October	62	5	0
Ingot bars	62	5	0
H.C. wire rods	67	0	0
Off. av. cash, July 54	11	8 5/16	
Do. 3 mths. July 54	19	9 1/2	
Do., Sttlmnt. July 54	11	6 1/2	
Do., Electro, July 60	6	6 1/2	
Do., B.S., July	58	15	3 1/2
Aver. spot price copper, July	54	11	8 1/4
Do., wire bars, July	60	11	3 1/4
Solid drawn tubes		12 1/2d.	
Brazed tubes		12 1/2d.	
Wire		9 1/2d.	

BRASS.

Solid drawn tubes	11 1/2d.
Brazed tubes	13 1/2d.
Rods, drawn	10 3/4d.
Rods, extd. or rlld.	7 1/2d.
Sheets to 10 w.g.	9 3/4d.
Wire	9 3/4d.
Rolled metal	9 1/4d.
Yellow metal rods	7 1/2d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets	8 1/4d.

TIN.

	£	s.	d.
Standard cash	292	0	0
Three months	286	10	0
English	289	5	0
Bars	289	2	6
Straits	293	2	6
Australian	293	2	6
Eastern	290	7	6
Banca	299	2	6
Off.avr.cash, July	288	16	3
Do., 3 mths., July	281	19	3 1/2
Do., Sttlmt. July	288	15	11 1/2
Aver. spot, July	288	16	3

SPELTER.

	£	s.	d.
Ordinary	27	18	9
Remelted	26	5	0
Hard	22	0	0
Electro 99.9	31	0	0
English	28	5	0
India	24	5	0
Zinc dust	37	0	0
Zinc ashes	10	10	0
Off. aver., July	28	3	0 1/16
Aver., spot, July	28	5	7

LEAD.

	£	s.	d.
Soft foreign ppt.	22	15	0
English	24	5	0
Off. average, July	23	14	2 1/2
Average spot, July	23	9	9 1/4

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	36	0	0
Do. V.M. ex whf.	34	10	0
Rods	42	0	0
Boiler plates	34	0	0
Battery plates	33	10	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	65	0	0
Chinese	47	0	0
Crude	37	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	21	15	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£8 15 0
45/50%	£12 12 6
75%	£19 17 6
Ferro-vanadium—	
35/40%	£14/3 lb. va.
Ferro-molybdenum—	
70/75% c. free	5/- lb.
Ferro-titanium—	
23/25% carbonless	11 1/2d.
Ferro-phosphorus, 20/25%,	£17 15 0
Ferro-tungsten—	
80/85%, c. fr.	1/3 1/2 lb.
Tungsten metal powder—	
98/99%	1/8 1/2 lb.
Ferro-chrome	
2/4% car.	£33 15 0
4/6% car.	£23 15 0
6/8% car.	£23 0 0
8/10% car.	£22 12 6
Ferro-chrome—	
Max. 2% car.	£36 0 0
Max. 1% car.	£42 0 0
Max.0.70% car.	£53 10 0
70%, carbonless	1/4 1/2 lb.
Nickel—99%, cubes or pellets	£170
Ferro-cobalt	9/3 lb.
Aluminium 98/99%	£105
Metallic chromium—	
96/98%	3/- lb.
Ferro-manganese (net)—	
76/80%, loose	£12 0 0
76/80%, packed	£13 0 0
76/80%, export	£11 15 0
Metallic manganese—	
94/96%, carbonless	1/10 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	s. d. 2 6
Finished bars, 18% tungsten	3 0

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares 3 in. and over	4d. lb.
Rounds and squares under 1/4 in. to 1/2 in.	3d. lb.
Do., under 1/4 in. to 1/16 in.	1/- lb.
Flats, 1/4 in. × 1/4 in. to under 1 in. × 1/8 in.	3d. lb.
Do. under 1/4 in. × 1/4 in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.
Bars cut to length	10% extra.

Scrap from high-speed tool steel—

Scrap pieces	3d.
Turnings and swarf	1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales—						
Hvy. steel	3	0	0	to 3	2	6
Bundled steel & shrngs.	2	12	6	to 2	13	6
Mixed iron & steel	2	12	6	to 2	13	6
Heavy cast iron	3	1	0	to 3	2	6
Good machinery for foundries	3	0	0	to 3	2	6
Cleveland—						
Heavy steel	2	15	0			
Steel turnings	2	4	0			
Cast iron borings	2	2	6			
Heavy forge	3	10	0			
Bushelled scrap	3	1	0			
Cast-iron scrap	3	0	0	to 3	6	0
Lancashire—						
Cast-iron scrap	3	5	0			
Hvy. wrought	3	2	6			
Steel turnings	2	2	6			

London — Merchants' buying prices delivered yard.

Copper (clean)	48	0	0
Brass (clean)	38	0	0
Lead (less usual draft)	20	10	0
Tea lead	18	0	0
Zinc	18	0	0
New aluminium cuttings	80	0	0
Braziery copper	45	0	0
Gunmetal	48	0	0
Hollow pewter	170	0	0
Shaped black pewter	130	0	0

PIG-IRON

(f.o.t. unless otherwise stated).

N.E. Coast—	
Foundry No. 1	70/-
Foundry No. 3	67/6
Foundry No. 4	66/6
Forge No. 4	66/-
Hematite No. 1	76/-
Hematite M/Nos.	75/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	85/-
,, d/d Birm.	94/-
Midlands—	
Staffs. common*	—
,, No. 4 forge	—
,, No. 3 fdry.	67/-
Shrops. basic	—
,, Cold blast, ord.*	—
,, ,, roll iron*	—
Northants forge	—
,, fdry. No. 3	61/9
Derbyshire forge	—
,, fdry. No. 3	67/-
,, basic	—
Scotland—	
Foundry No. 1	—
,, No. 3	75/6
Hem. M/Nos.	78/6
Sheffield (d/d district)—	
Derby forge	69/-
,, fdry. No. 3	71/6
Lincs. forge	—
,, fdry. No. 3	71/6
E.C. hematite	89/-
W.C. hematite	91/6
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3	75/6
Northants foundry No. 3	—
Dalzell, No. 3	105/- to 107/6
Summerlee, No. 3	93/- to 100/-
Glengarnock, No.3	93/- to 100/-
Gartsherrie, No.3	93/- to 100/-
Monkland, No.3	93/- to 100/-
Coltness, No. 3	93/- to 100/-
Shotts, No. 3	93/- to 100/-

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

	£	s.	d.	£	s.	d.
Iron—						
Bars (cr.) nom.	9	15	0	to 11	0	0
Angles				—		
Tees to 3 united ins.				—		
Nut and bolt iron				—		
Hoops				14	10	0
Marked bars (Staffs.) f.o.t.				13	10	0
Gas strip				12	10	0
Bolts and nuts 3/4 in. × 4 in.				15	5	0
Steel—						
Ship plates				8	2	6
Boiler plts.				11	0	0
Chequer plts.				10	5	0
Angles				7	12	6
Tees				8	12	6
Joists				7	12	6
Rounds and squares 3 in. to 5 1/2 ins.				7	15	0
Rounds under 3 in. to 3/8 in. (Untested)				8	0	0
and upwards						
Flats, over 5 in. wide and up				9	2	6
Flats, 5in. to 1 1/2 in.				8	2	6
Rails, heavy				8	2	6
Fishplates				12	10	0
Hoops (Staffs.)				10	10	0
Black sheets, 24g.				10	7	6
Galv. cor. shts, 24g.				14	0	0
Galv. fencing wire 8g. plain				12	10	0
Billets, soft 6	0	0	to 7	0	0	
Billets, hard				8	2	6
Sheet bars	5	12	6 to 5	15	0	
Tin bars d/d	5	15	6 to 5	15	0	

PHOSPHOR BRONZE.

	Per lb.	basis.
Strip	1	2 1/2
Sheet to 10 w.g.	1	2 1/2
Wire	1	3 1/2
Rods	1	2 1/2
Tubes	1	8
Castings	1	2

Delivery 3 cwt. free.

10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.

C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3 1/2 to 1/9 1/2
To 15 in. wide	1/3 1/2 to 1/9 1/2
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4 1/2 to 1/10 1/2
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5 1/2
Ingots rolled to spoon size	1/- to 1/8 1/2
Wire round—	
3/0 to 10 G.	1/6 1/2 to 2/1 1/2

with extras according to gauge.

AMERICAN IRON & STEEL

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	20.76
No. 2 foundry, Valley	17.50
No. 2 foundry, Birm.	17.25
Basic	20.00
Bessemer	20.26
Malleable	19.26
Grey forge	18.76
Ferro-mang. 80% d/d	90.00
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y at mill	43.00
Bess billets	33.00
O.-h. billets	33.00
O.-h. sheet bars	34.00
Wire rods	43.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.80
Tank plates	1.80
Beams, etc.	1.80
Skelp, grooved steel	1.80
Skelp, sheared steel	1.80
Steel hoops	2.30
Sheets, black, No. 24	3.00
Sheets, galv., No. 24	3.85
Sheets, blue an'l'd, 9 & 10	2.25
Wire nails	2.55
Plain wire	2.40
Barbed wire, galv.	3.25
Tinplate, 100 lb. box	$5.50

COKE (at ovens).

Welsh foundry	—
,, furnace	—
Durham & North.	
,, foundry	—
,, furnace	15/-
Other Districts, foundry	—
,, ,, furnace (basis)	12/6

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes,	20 × 14, box	18/4 1/2
,,	28 × 20, ,,	36/6
,,	20 × 10, ,,	—
,,	18 3/4 × 14, ,,	—
C.W.	20 × 14, ,,	16/9
,,	28 × 20, ,,	—
,,	20 × 10, ,,	—
,,	18 3/4 × 14, ,,	—

Terneplates 28 × 20, — per box basis f.o.b.

SWEDISH IRON.

Bars, hammered	£18/10 to £19/0
Rolled Ord.	£15/5/0 to £15/15
Nail rods	£15 12 6 to £16 0 0
Keg. steel nom.	£33 to £35
Faggot steel nom.	£22 to £25
Blooms, according to quality	£8 to £12
Pig-iron all f.o.b. Gothenburg.	£6 0 0 to £6 10 0

TUBES AND FITTINGS.

Up to and incl. 6 in.

	Tubes.	*Fittings*
Gas	67½%	45%
Water	62½%	40%
Steam	57½%	35%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (Cash).

	£	s.	d.	
Aug. 18	55	1	3	No change
,, 19	55	3	9	inc. 2/6
,, 22	55	3	9	No change
,, 23	55	0	0	dec. 3/9
,, 24	54	15	0	,, 5/–

Electrolytic Copper.

	£	s.	d.	
Aug. 18	62	0	0	dec. 5/–
,, 19	62	0	0	No change
,, 22	62	5	0	inc. 5/–
,, 23	62	5	0	No change
,, 24	61	15	0	dec. 10/–

Standard Tin (Cash).

	£	s.	d.	
Aug. 18	291	5	0	dec. 5/–
,, 19	291	15	0	inc. 10/–
,, 22	289	10	0	dec. 45/–
,, 23	289	2	6	,, 7/6
,, 24	292	0	0	inc. 57/6

Tin (English ingots).

	£	s.	d.	
Aug. 18	288	15	0	inc. 10/–
,, 19	288	15	0	No change
,, 22	287	10	0	dec. 25/–
,, 23	287	2	6	,, 7/6
,, 24	289	5	0	inc. 42/6

Zinc Sheets (English).

	£	s.	d.	
Aug. 18	36	0	0	No change
,, 19	36	0	0	,, ,,
,, 22	36	0	0	,, ,,
,, 23	36	0	0	,, ,,
,, 24	36	0	0	,, ,,

Spelter (ordinary).

	£	s.	d.	
Aug. 18	28	0	0	inc. 2/6
,, 19	28	0	0	No change
,, 22	27	17	6	dec. 2/6
,, 23	27	15	0	,, 2/6
,, 24	27	18	9	inc. 3/9

Lead (English).

	£	s.	d.	
Aug. 18	24	5	0	No change
,, 19	24	5	0	,, ,,
,, 22	24	5	0	,, ,,
,, 23	24	5	0	,, ,,
,, 24	24	5	0	,, ,,

Exports of Iron Castings in July and the seven months 1927, compared with July and the seven months 1926.

	July, 1926.	July, 1927.	Seven months, 1926.	Seven months, 1927.	July, 1926.	July, 1927.	Seven months, 1926.	Seven months, 1927.
	Tons.	Tons.	Tons.	Tons.	£	£	£	£
BUILDERS' CASTINGS—								
Stoves, Grates, etc., Cisterns, Baths, etc., and cooking and washing boilers—								
To Argentine Republic	122	132	783	969	7,155	5,751	33,097	35,853
,, British South Africa	135	188	2,496	1,666	5,930	6,861	85,112	59,889
,, ,, East Indies	164	73	1,048	978	7,125	3,771	46,349	45,392
,, Australia	91	50	557	592	4,110	2,816	30,851	33,439
,, New Zealand	171	91	1,359	1,289	8,823	5,005	65,598	65,755
,, Other countries	759	494	4,682	4,351	33,712	26,540	222,100	220,623
Total	1,442	1,028	10,925	9,845	66,855	50,744	483,107	460,951
PIPES AND FITTINGS,—CAST—								
To Argentine Republic	513	550	5,156	6,079	6,095	6,363	64,243	65,746
,, British South Africa	1,319	1,925	5,057	4,714	14,214	19,479	67,064	64,869
,, ,, India	499	774	5,732	4,160	7,361	15,405	71,885	65,124
,, Straits Settlements and Malay States	934	1,623	10,796	8,042	9,874	14,592	91,851	79,487
,, Ceylon	165	4	1,399	791	1,690	77	15,331	9,547
,, Australia	387	719	2,935	5,601	6,355	8,623	38,307	64,862
,, Other countries	4,058	7,697	30,306	34,486	57,091	89,564	412,710	459,150
Total	7,875	13,292	61,381	63,873	102,680	154,103	761,391	808,785
HOLLOW-WARE—								
Cast, not Enamelled, and Cast, Tinned	634	278	4,080	2,740	25,089	12,215	142,343	107,332
,, Enamelled	74	44	541	407	9,707	5,164	57,533	41,052
CASTINGS, in the rough—								
Iron	143	66	977	651	3,554	2,141	27,014	24,217
Steel	86	102	486	522	2,736	4,523	14,005	23,442

WILLIAM JACKS & COMPANY,

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1, HONG KONG ROAD, SHANGHAI.

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5, SHAFFRAZ ROAD, RANGOON
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1 SHAREH SONK EL TEWFIKIEH, CAIRO.

PIG IRON

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.,

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE

WILLIAM JACKS & COMPANY,

19, ST. VINCENT PLACE, GLASGOW.

ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

Notice.

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(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED.

ADVERTISER, twenty years' practical Foundry experience, five years' commercial travelling, seeks change, as Representative of first-class Foundry requisite and equipment manufacturers; please state terms and territory.—Box 386, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

CORES.—Advertiser wishes to meet firms who are desirous of increasing their production of small Cores, or who are interested in making Castings from Oil Sand Cores, by up-to-date methods. Core output can be increased from 100 to 500 per cent.—P. D. Mills, 32, Windsor Road, Stirchley, Birmingham.

FOUNDRY MANAGER desires position; 25 years' practical and technical experience with largest firms in engineering; first-class references.—Address, Box 372, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY MANAGER, with small capital, requires opening, for active participation in live concern; near London preferred.—Box 400, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY MANAGER, fully experienced and practical, desires re-engagement in similar capacity in any part of the country; would also consider acting as Representative to any firm of Ironfounders requiring regular supplies of Castings, or as Traveller to a reputable firm of Foundry Requisite Suppliers.—Box 380, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

PRACTICAL Foundry Foreman, aged 34, disengaged, desires similar position; working not objected to; well trained in loam, dry sand, green sand, oil sand, and cupola practice; engineering or jobbing preferred.—Box 396, offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

YOUNG MAN (21), three years' foundry and two engineering experience, desires situation, preferably commercial.—Box 254, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

ASSISTANT FOREMAN MOULDER wanted in large Iron Foundry (South Midlands); must be progressive and thoroughly experienced in efficient and economical output of Light General Engineering Castings, also Machine Moulding; intimate knowledge of cupola practice essential; a good opportunity for an energetic man.—Write, giving full details, experience, age, salary, and names and addresses of last two employers, all correspondence treated in strict confidence, to Box 378, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY MANAGER wanted, for large foundry in North of England; a qualified engineer, with good experience of foundry management and organisation will be preferred.—Apply, with detailed particulars, and state salary required, to box 398, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

WANTED, Sales Promotion Engineer, with extensive knowledge of engineering concerns, to assist in Sales Organisation in an Aluminium Foundry and Engineering Works, near London.—Reply, stating age, salary required, and full details of experience, to Box 384, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

PATENTS AND TRADE MARKS.

INFORMATION HANDBOOKS. Advice, and Cons. free; King's Patent Agency, Ltd.—B. T. King, C.I.M.E. (Regd. Pat. Agent, G.B., U.S.A., and Can.), 146a, Queen Victoria Street, E.C.4. 40 years' refs. 'Phone: 0682 Central.

PATENTS AND TRADE MARKS.—*Continued.*

THE Proprietor of British Patent No. 205,973, dated October 2, 1922, relating to "Foundry Moulding Machines," is desirous of entering into arrangements by way of a licence or otherwise on reasonable terms for the purpose of exploiting the above patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. Singer, Steger Building, Chicago, Illinois.

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RAILWAY SIDINGS to L.M.S. and L.N.E. Rlys. Area about 11 acres, FREEHOLD. Works well situated and compact. Floor space about 145,000 sq. ft.

Full particulars and terms furnished on application.

THOS. W. WARD LTD.,

ALBION WORKS, SHEFFIELD.

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FINEST MOULDING SAND for Foundry work. Prices quoted ex pit or delivered; samples sent.—A. Otterway, Thorpe, Surrey. 'Phone: Egham 353.

CHARCOAL.—Powdered, granulated, lump, blacking; inquiries invited.—J. Buchanan & Company, Ashfield Road, Altrincham, Cheshire.

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SAND, the best, for foundry purposes; samples and particulars free.—Smithson, Woodlands, Holme, York.

PATTERNS.—Inquiries solicited; quotations by return; shop equipped with modern machinery; quick delivery.—Cleghorn & Company, Midland Pattern Works, Spring Gardens, Worcester. 'Phone 26.

MOULDERS' MATERIALS.—Plumbago, Blacking, Parting Powder, Terra Flake, Metallic Cement, Wax Core Vents, etc.; carriage paid terms.—W. Olsen, Ltd., Cogan Street, Hull.

MACHINERY.

GERMAN MANUFACTURERS.—Firms wishing to get into touch with makers of German goods should state their wishes to Box 802, c/o Hermann J. Fromm, Advertising Agency, Berlin, W.35, Lützowstr. 84. This information is provided for the use of buyers and not for individuals on the look-out for an agency.

SAND MIXERS.—New and second-hand. Ask us to quote. — W. Brealey & Company, Limited, Prospect Works, Hawksley Avenue, Sheffield.

'Phone: 287 SLOUGH.

TRY HAMMOND FIRST

NEW OIL SAND MIXER, latest type	..	£14
NEW ½ Ton LADLE (enclosed gear)	..	£14
NEW 1 Ton LADLE, "COLLIN"	..	£20
NEW 1½ Ton LADLE, "COLLIN"	..	£24
NEW 2½ Ton LADLE, "GREEN"	..	£28
3 Ton "EVANS" LADLE, Good as New	..	£30
12 Ton "EVANS" LADLE, Good as New	..	£70
1 Ton DAVY STEEL CONVERTOR, with Motor and Tilting Gear	.. .. ..	£120

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